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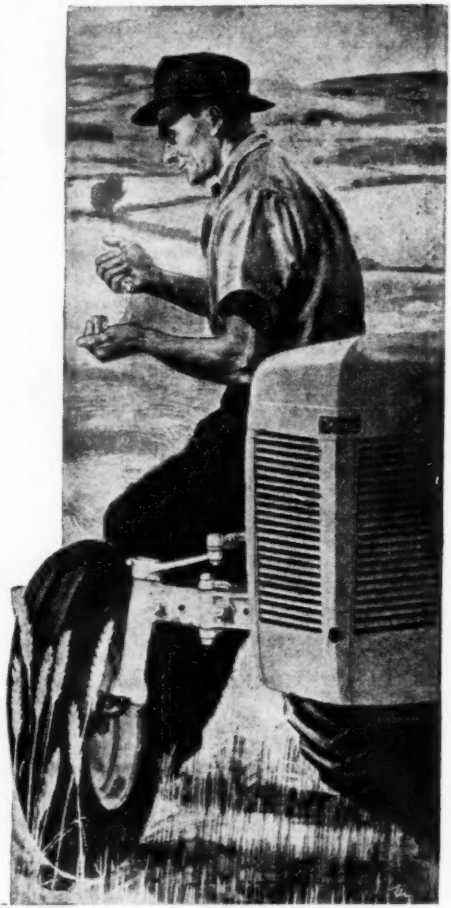

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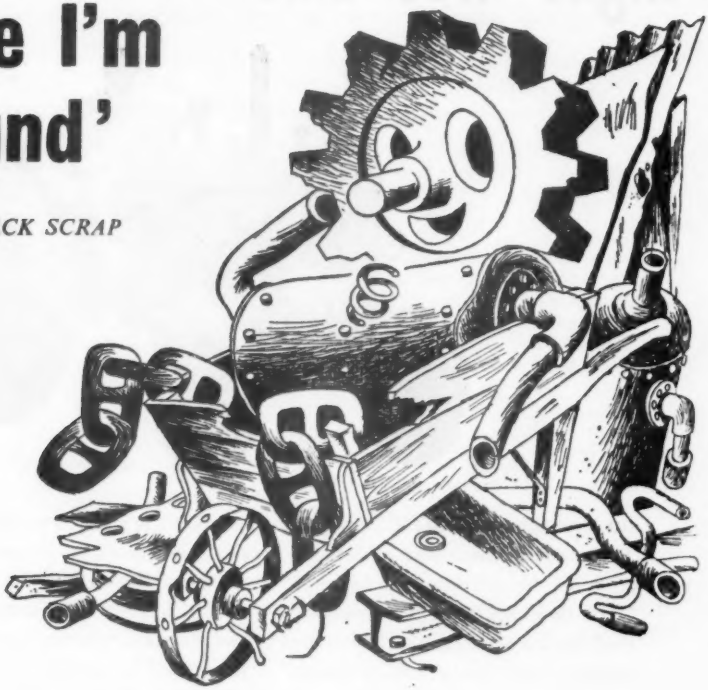

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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices : St. Andrew's Place, Regent's Park, N.W.1 (*Phone* : *WELbeck* 7711)

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Cover Photograph

Haymaking near the Hog's Back, Guildford, Surrey

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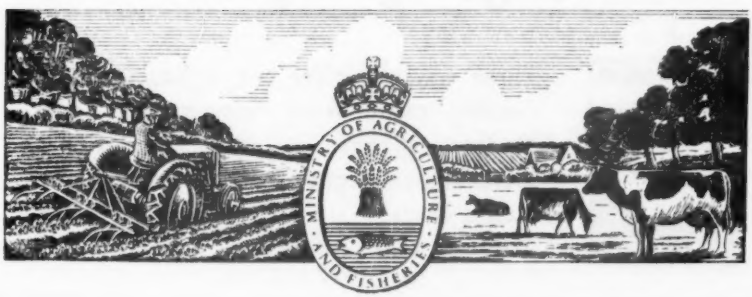

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SOIL AND CIVILIZATION

G. V. JACKS, M.A., B.Sc.

Director, Commonwealth Bureau of Soil Science

IT is almost impossible for men to study men with the same objective detachment with which they study, say, pine trees. For example, there are some aspects of human behaviour that by common consent are regarded as bad, and others that are regarded as good, and our knowledge of good and evil must to some extent influence our approach to questions of human ecology. A thinking pine tree might be similarly influenced in its approach to forest ecology. It would recognize good pines that fell over and gave up their lives that others might have more light and air, and bad, bloated pines that stretched out their roots far and wide, grabbed all they could and sucked the sap from hundreds of starving plants and innocent seedlings. Yet plant-ecological man, studying the same forest, would think the bad pines good and the good pines bad : he would see their individual struggles as normal responses to competition and environment and might find nothing in the forest worthy of comment until man himself, responding in his turn normally to his environment, cut down the trees and " upset the balance of nature." To man, there is Nature and Man who interferes with her ; to the pine, also, there is Nature (including man) and the Pine which interferes with her by occupying land that otherwise would "naturally" be under agriculture.

These reflections are evoked by reading Mr. Edward Hyams's recent book *Soil and Civilization*,* in which he has attempted to relate the growth of civilizations to the soils on which they have developed. It is a theme fundamental to human ecology because men, alone among the animals, make permanent, enduring settlements on wide areas of land and can thus, like plants, assume a dominant role in the process of soil evolution. These enduring settlements correspond roughly with the popular concept of civilizations. Mr. Hyams overlooks this essential ecological feature of civilization and includes, in the numerous civilizations he reviews, nomadic and rural societies whose effects on soil formation are as small as those of other animal societies. He is primarily an historian and archaeologist, and gives a most interesting account of the beginnings of agriculture in different parts of the world, but he fails to show that there is any relationship between a man-dominated civilized community and the soil producing it, that is comparable to the relationship between a plant-dominated community and its soil. He approaches his subject from a quasi-religious angle, that is, that man, alone of living things, has the option of being or not being a part of Nature ; when he increases soil fertility he is helping Nature, and when he exhausts soil fertility he outrages her.

* Published by Thames and Hudson. 21s.

The cult of fertility, which, as Mr. Hyams shows, had a great influence on the early development of agriculture, continues to this day and includes among its adherents not only the author himself but most of the best farmers in the world. It does not, however, provide a suitable basis for an objective study of civilization in relation to the soil. Mr. Hyams regards industrialists, scientists and moneylenders as violators of Nature, who inflict damage on the soil. But they also serve their purpose. It is dangerous to generalize about soil fertility ; nevertheless it is fairly safe to say that the most productive soils in the world surround cities where industrialists and their like exert their greatest influence. It is useless to embark on a study of human ecology and soil with preconceived ideas of what human society ought to be and do.

Man and Environment In human affairs the peculiar powers conferred on us by our brains and hands so dominate our daily lives that we tend to give them an inordinate significance in the scheme of nature. These powers and other human attributes have, however, conferred ecological dominance on man over a much smaller area than the area over which the acid humus produced by a pine forest has given dominance to the pine. To an extra-terrestrial observer of terrestrial ecology, man would appear as a species of animal peculiar only in that he formed permanent, fixed settlements (cities) which sometimes enabled him to dominate the soil and everything it produced. Whether dominance is achieved by the power of mind, spirit, axes, bulldozers or any other force is almost wholly irrelevant.

Let us assume that a being from the planet Neptune visited the Earth once every Neptunian year (which is 165 of our years) for fifty years, to study ecology. The fifty Neptunian years would cover rather more than the span of the history of civilization. We shall call the Neptunian "It," because we must not assume that It is animal or vegetable or even sexed. How would Its studies develop ?

On Its first reconnaissance trip It would notice that most of the dry land, except the almost lifeless polar and desert regions, was dominated by trees in the wetter areas and grasses in the drier areas, and that the forests and grasslands were associated with different kinds of soils. It would also notice that forests produced soils suited for forest communities, and grasslands soils suited for grassland communities, and that animals, owing to their motility, had little control over soil development and played ecological roles subordinate to the plants they consumed. A few trips later It would observe that along the banks of some rivers flowing through desert areas, members of the animal species, man, were congregating in cities built to last and, by regulating the river waters, were exercising a decisive influence on soil formation, turning the desert sands into soils admirably suited for producing the plants which man ate. It would see that a new type of living community was evolving, consisting of a dominant stratum of men, living mainly in cities, who induced other men who cultivated the soil to produce conditions suitable for the growth of the mainly graminaceous plants which were the food of the dominants and their attendant animals. It would observe that at first men only became dominant by watering a desert ; they could not wrest dominance from an already established plant community, although they could graze livestock on grasslands, and even cultivate the land for a short period until they had exhausted the soil.

In subsequent visits our Neptunian would observe that civilization had spread into the dominions of the forests. It would know nothing about the Bronze Age and the Iron Age, or the invention of ploughs, axes and

fertilizers. It would merely conclude that civilized man had succeeded in adapting himself so well to new environments that he could oust the plant world from its dominions. It would observe that all civilizations, like all pine forests, had the same basic structure and produced the same kind of soil : that most civilized people lived in towns with little productive soil, and induced the remaining rural dwellers to produce a soil which over long periods of time would yield large crops of mainly graminaceous plants. It would not be surprised, therefore, to find that the soil of civilization had some resemblance to a grassland soil ; there was a similar crumb-like structure, but the soil was richer in plant food and moisture and altogether more fertile—as would be expected from something that was made by and for a community with exceptionally exacting requirements. Our Neptunian might even speculate, as perhaps Mr. Hyams does, whether civilization does not represent the supreme ecological climax, when the soil has reached the highest level of fertility it will ever attain. It might coin the word "economics" to describe the force that activates the struggle for existence alike in human and plant societies.

Soil, Life and Climate It would observe, after many visits to the Earth, that man-dominated civilizations had not the same permanence as plant-dominated societies. The undisturbed forests and grasslands have scarcely changed during the period of human history, while a score of civilizations have risen to power and sunk to a state of relative impotence in which the human community is no longer the absolute master of its environment. Only one civilization—that of Egypt—has lasted throughout the whole period.

This instability of man-dominated communities might present our Neptunian with a difficult problem to solve, but It would find it easier if It approached the problem untrammelled by historical facts—that is, from a purely ecological standpoint.

Plant-dominated communities are, by natural selection, composed of species all of which are specifically adapted to the prevailing climate, and they make soils which are the product of the action of both climate and living things on weathered rock. Thus trees flourish in moist climates which tend to produce leached soils which trees like, and grasses flourish in dry climates which produce soils in which plant nutrients are evenly distributed, like the grass roots, in the surface layers of soil. As a result, a very stable equilibrium is set up between climate, soil and life—so stable, indeed, that the only event likely to disturb it beyond recovery is the incursion of civilized man. A man-dominated community, on the other hand, tends to have the same kind of associated flora and fauna and to produce the same kind of soil in whatever climate it arises. This is recognized when we say that few of our cultivated plants are "natural" ; in other words, they are not naturally adapted to the climate. The soil of civilization, also, is not a product of the climate, but almost entirely of human activities, often working on soil evolution in an opposite direction to the climate. The tripartite equilibrium of climate, soil and life is thus replaced, in man-dominated communities, by a less stable, bipartite equilibrium of soil and life. Where the climate is favourable to the formation of the soil of civilization, therefore, a more stable equilibrium may be expected than where it is unfavourable.

In Egypt, the man-made soil climate under basin irrigation is ideal for the purpose ; nowhere else in the world are conditions for creating the perfect agricultural soil and climate so favourable and so easily controlled. Elsewhere, man, in striving to create a soil suitable for permanent agriculture,

is always to some extent fighting the climate (which hitherto he has only been able to control by irrigation). In Western Europe it has been a particularly hard and long fight, for only within the last hundred years or so has man become the undisputed dominant and made a soil which, if inherently unstable in the climate, exceeds in agricultural productivity all other soils the world has known. The chief agents in this perhaps ephemeral victory have been the scientist and the industrialist who inspired the scientist, delivered the goods, and created a demand for greater productivity from the soil. Mr. Hyams regards both with respectful disparagement.

These two extreme types of civilization—the earliest and the latest to reach maturity—are contrasted, the one by its ecological stability, the other by its social instability (which a Neptunian would not observe and which may have no ecological significance). Egyptian civilization having easily and quickly mastered its environment, did nothing of note between building the Pyramids and building the Assuan Dam. European civilization, on the other hand, has been exceptionally dynamic. It has never completely conquered its environment, and its restless, dynamic nature may be connected with its never-ending struggle to overcome the limitations imposed by a climate in which it is too wet and too cold for the soil of civilization to be stable. So, at least, it might appear to a Neptunian who knew nothing and cared less about the proud achievements of terrestrial science. To us on this Earth, with our limited powers of imagination, it is difficult to see how soils of such great fertility could have been formed without the incentives provided and the wealth created by intense industrialization.

Social Structure Although civilizations all have the same general structure, there are differences of detail in the social structure of different civilizations that may have ecological significance. Here the original, plant-dominated soil type comes into the picture. If we agree that all civilizations tend to produce the same type of agriculturally highly-fertile soil, we should expect, as indeed we find, that different social organizations would be required to transform the desert soils of Egypt, the red soils of the Mediterranean and the brown soils of Western Europe, respectively, into the soil of civilization. Actually, in many cases there is a rough correspondence between areas occupied by distinct plant-dominated soil groups and man-dominated civilizations. Thus the *man-dominated* area of the Roman Empire was confined mainly to the region of Mediterranean red soils, even though Roman power and culture extended as far as Britain, and the area of intensive European agriculture and its associated industrialized society is very roughly coincident with that of the former brown deciduous-forest soils. This suggests that the external environment, as expressed in the "natural" soil type, does have an influence on the social evolution of human as well as of plant communities, and that this influence might be traced from a study of history.

Here, however, we enter the realm of speculation which, though very healthy for humans, would be avoided by our Neptunian. If It mastered English spelling, It could read *Soil and Civilization* and learn much useful history that might enable It, with Its acquired ecological background, to elucidate some of the finer points of human relationships with the soil, in which passions like politics and religion have played a part. But that is another story.

MUTTON FROM MACHYNLLETH

R. PHILLIPS, M.Sc.

University College of Wales, Aberystwyth

From the returns examined at certain Welsh collection centres, Mr. Phillips draws attention to the influence of climate on fat lamb and sheep production, and the need to equalize seasonal supplies.

WE can learn a great deal about the farming of an area from examination of the returns of the fat stock collecting centre or grading centre of that district. In a study of the returns of the twenty-five collecting centres of the Ministry of Food in Dyfed*, it has been shown that, although there are considerable differences in the annual numbers delivered, yet in any particular centre the average body size or the estimated dressed carcass weight (E.D.W.) of lambs and sheep remains remarkably constant over a number of years. Consequently, differences between various centres remain unchanged, and even the data for 1947, with its hard winter and late spring, did not alter things. Thus the Aberystwyth centre produces lambs of an average estimated dressed carcass weight of 30 lb. ; Tregaron 28 lb. ; Lampeter 33 lb. ; Haverfordwest 47 lb. ; and Pembroke 53 lb. The factors responsible for these differences from place to place are the breed, the type of land, the system of farming, etc., but the dominating influences are the results of climatic differences. The three elements of weather, rainfall, temperature and hours of bright sunshine, together with the length of day, profoundly affect farming, particularly in the duration of the grazing season. Where the rainfall is moderately low, and the temperature and proportion of sunshine hours each day are high, then the area is capable of producing heavy weights in sheep and cattle. But where the contrary conditions prevail, then the region or district produces lambs, sheep and cattle of much lower weights.

Seasonal Supplies Recently, information has been obtained from the grading returns of the Machynlleth and Cemmaes collecting centres in west Montgomeryshire. These are important centres for fat sheep and lambs, and in 1949 and 1950 over 22,000 passed through Cemmaes and over 14,000 through Machynlleth. The surrounding areas supplying these two centres consist of both lowland farming country and upland rough grazings; consequently, large numbers of both summer fat lambs and of autumn-fed wether lambs are delivered to these two grading centres. Fully 85 per cent of the annual deliveries are made during the last four months of the year (September-December) and only 15 per cent during the remaining eight months. If we assume that the deliveries during June, July, August and September are the lowland fat lambs, and those during October, November, December and January the fat wether lambs of upland origin, then for every lamb of the lowlands group there were nearly 3 wether lambs from the uplands during the two years.

These two important facts indicate that we are fast becoming an autumn meat-producing country, and that the sheep and lambs of upland origin are of greater importance in our meat supplies than those from the lowlands. At Machynlleth in 1950, only 53 lambs were supplied during the four months

* The Influence of the Environment upon the Estimated Dressed Carcass Weight of Fat Sheep in West Wales, 1943-46. R. PHILLIPS and E. H. BROWN. *J. agric. Sci.*, **40**, 341-55

February-May, while 10,000 were delivered during the four months September-December. This explains one of the difficulties of levelling the meat ration throughout the weeks of the year, because not only is there a glut in the deliveries of mutton and lamb in autumn, but it coincides with a similar glut in the deliveries of beef cattle of all descriptions, including calves. The capacity of the meat refrigerating stores is limited and consequently the meat ration is increased at that time of the year and reduced during the period of scarcity in spring. Likewise, two hundred years ago the glut of autumn meat, imposed by a shortage of winter fodders, was preserved as salted beef and mutton.

The Machynlleth Returns for 1950 The Machynlleth returns have been examined in greater detail for 1950 when over 14,000 sheep and lambs were bought by the Ministry of Food. The sale of lambs accounted for 77 per cent of the total, ewes made 10 per cent, yearlings and wethers or "sheep" 12 per cent and rams 1 per cent. The 14,000 that went through the collecting centre is not the whole of the sheep trade of this district ; large numbers of draft ewes from the upland flocks are exported for further breeding. In addition, many wether lambs are sold as stores for fattening elsewhere. Fat lambs are the most important section of the meat trade at present ; the small proportion of yearlings and wethers, (12 per cent) is a reflection of the changes that have taken place in sheep husbandry in recent decades. The public demand for lamb instead of mutton forced the industry to abandon the old practice of keeping wethers on the hills and mountains of Wales. There are many who deplore this change because it has affected the numbers as well as the structure of the hill flocks and has reduced materially the output of wool. It has been found that in 1950 for Great Britain as a whole, the yearlings and wethers contributed 15 per cent of the total supply. Further, 43 per cent of the annual deliveries of this category were made during June, July and August and 26 per cent during April, May and June. Consequently a greater proportion of yearlings and wethers in the annual deliveries would tend to level out the national supply of mutton and lamb during the year.

At Machynlleth, however, the peak deliveries of all the separate categories occur in the autumn. In the case of rams for example, 51 out of the 110 sold during the year were delivered in October. In days gone by, rams could only be sold for mutton in late spring, when there was a scarcity of meat. It seems that the idea of "quality" in meat has disappeared from the minds of producers and retailers since ram mutton is now thrown on the market at the time of the glut. It is safe to assert in regard to meat that the quality is sacrificed when the supply is short.

The average estimated dressed carcass weights have also been obtained from the 1950 Machynlleth records. These were as follows : lambs 28.7 lb.; ewes 33.7 lb. "sheep" 39.1 lb.; and rams 46.5 lb. If lambs are taken as 100, then ewes are 117, "sheep" 136 and rams 162. It is surprising to find that the light-weight ewes of this area produce lambs which, before they attain the age of 6 months, are within 20 per cent of the size of their mature mothers. This is proof of the excellent nursing and milking qualities of the small Welsh mountain ewe. Probably no other breed or class of ewe in this country can achieve that distinction in such a short time. Amongst these 11,000 lambs which make up this average, there are many which are heavier than the "average" ewe, although as shown opposite, the E.D.W. of the average ewe is heavier than that of the average lamb during each month.

MUTTON FROM MACHYNLLETH

The Machynlleth lamb is a small one (some 28 lb.). Only 10 per cent of the deliveries have a carcass weight of over 35 lb. Only 50 per cent of the summer suckling lambs delivered during June, July and August (20 per cent of the annual total) are over 35 lb. E.D.W.

The average monthly E.D.Ws. of all categories are shown in the following table for the months June—January only ; there are too few deliveries in the other months.

Average Estimated Dressed Carcass Weights (lb.)
Machynlleth Centre, 1950

	June	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Lambs ..	35.1	36.3	34.3	30.2	27.1	26.0	29.0
Ewes ..	38.4	39.0	38.3	34.2	32.0	28.0	32.0
Sheep ..	36.0	39.0	34.4	35.4	38.0	34.6	43.1
Rams ..	48.0	38.0	66.0	47.0	43.7	46.2	52.8

The table shows that the average summer fat lamb of the lowlands (June, July and August) is about 10 lb. heavier in carcass weight than the fattened wether lamb of upland origin in the autumn. This illustrates several important principles in fat lamb production :

1. The size of the fat lamb, when sold for slaughter, depends upon the nutrition of its dam during pregnancy and during the early nursing period. In these respects, the lowland ewe has the advantage over her hill and mountain sister.
2. Milk and grass for the young lowland lamb in summer provide a better diet than upland pasture with little milk, or rape and grass in autumn for the growth and fattening of the older wether lamb.
3. Climate affects the rates of growth and of fattening. The fairly dry, warm conditions of the lowlands in summer are infinitely better than the wetter and colder conditions of the autumn.

Although at Machynlleth the summer fat lamb (pure-bred or cross-bred) is heavier than the wether lamb of autumn, this order in size is not obtained everywhere. In parts of west Pembrokeshire, east Montgomeryshire and Herefordshire, where the conditions are better, both as regards food and climate, the winter lamb is heavier than the autumn one, which is also heavier than the summer lamb. In other words, under good conditions the right class of lambs grow and fatten continuously as they get older, whilst under poor conditions the lambs fail to gain weight and may lose condition during the raw wet weather from November to January. Many lambs at Machynlleth grade below 25 lb. E.D.W. during this period.

The table also shows that the monthly E.D.W.s of the ewes follow that of the lambs, but in the case of yearlings and wethers the reverse is true.

Price Levels Farmers are familiar with the range of prices per lb. E.D.W. for lambs ; these are highest during the period of scarcity in early summer and lowest during the glut season of deliveries in October and November. In 1951 the price per lb. E.D.W. in June was 31d. when few were marketed and 27d. during the following October and November when 50 per cent of the lambs were delivered at this centre. That is, the price falls by 4d. per lb. E.D.W. within a period of 6 months ; it amounts to a difference of 10s. 8d. in the price of a 32-lb. lamb between June and November. The State has subsidized the hill ewe by sums varying from a minimum of 2s. 6d. in 1941 to a maximum of 16s. in 1948, but the produce of that ewe when marketed as fat wether lamb in autumn is 10s. 8d. less in

value (per 32 lb.) than if it were marketed in the following June. Unfortunately, the lambs under the conditions prevailing in this area cannot be carried forward into the spring. In contrast, the bigger lambs of warmer and drier climates in better areas will increase in weight when kept until the following spring, and thus gain in weight and appreciate in value.

Many people consider that to sustain marginal and upland sheep production there should be a differentiation in price per lb. E.D.W., or in "headage bonus" to favour the small lambs, which produce meat of the best flavour with the least waste. The big fat lambs of the West Midlands and Welsh Border country, when marketed at 10–12 months, leave far more waste in fat and bone than these small hill lambs.

The examination of returns of the collecting centres have shown (a) that an increase in the numbers of lambs is a far more effective means of increasing meat supplies than an increase in the size of the individuals ; (b) that it is actually easier to increase numbers than size in any given district ; (c) that deliveries of fat sheep and lambs should be more evenly distributed throughout the year ; and (d) that efforts should be made to delay the autumn glut deliveries so as to fill the spring gap.

It is obvious that the provision of food for the flock during all the seasons of the year, particularly during the period of the greatest losses in sheep (January—April), is of the greatest importance in modern sheep husbandry. It is suggested that the cross-bred lambs now being delivered to collecting centres such as Machynlleth and Cemmaes during the summer months should be transferred to the better sheep areas for further growth and fattening, and to yield a carcass of 50–56 lb. by the following February or March. This should not apply to the early-maturing pure Welsh lambs or to the small Welsh wether lambs in autumn, since these do not possess the frame to carry a large amount of meat like the cross-bred lambs of Welsh × Kerry parentage.

The importance of the lamb of upland origin should again be stressed, because at present, it is numerically the most important. Husbandry schemes such as the traditional *hafod* and *hendre** should be encouraged because at the present time the stocking of sheep on the hills is too low during the summer and too high in winter. This system would increase the stock on the hills during the summer but would decrease it during the winter and thereby reduce the risks of heavy losses which occur in the upland flocks before and after lambing.

* *Hafod* = summer grazing ; *Hendre* = winter homestead.

HUSK IN ADULT CATTLE

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Lush herbage provides the conditions under which the husk worm can thrive. Dr. Taylor suggests that, from the preliminary investigations at the Veterinary Laboratory, modern improved leys should be grazed judiciously.

THE trial of new methods is always spiced with a certain amount of risk, so that there has been a flavour of adventure in the pursuit of the recent advances in grassland management. Farmers who have been ready to take on the role of amateur experimentalist have done much to hasten the progress towards the goal of a self-supporting husbandry in this fertile country of ours ; it is these pioneers who first reap the benefits from new methods, but it is also they who find the hidden dangers that only experience can reveal. One of these dangers has been brought forcibly to our notice during the past year with the greatly intensified productivity of ley pastures. The improved strains of grasses and clovers, the intensive use of fertilizers and the practice of strip grazing have enabled us to make two blades grow where one grew before, but it now appears that, all unseen, we have been cultivating the husk worm with similar success, making two grow where only one grew under the old system, and in some instances perhaps causing hundreds to grow where only one grew before.

There have been numerous outbreaks of husk among milking cows during the past season. The disease is well known among calves and yearlings but it is something new to find a widespread occurrence in the milking herd where, in some instances, every animal has been more or less seriously affected. Work has been in progress at the Ministry of Agriculture's Veterinary Laboratory in an endeavour to explain it and to find some means of prevention. Although we are still very far from a complete understanding, certain indications appear to be sufficiently clear to warrant the publication of this article.

The husk worms will be known to some unfortunate farmers, who may have seen them at a post-mortem examination, as white thread-like worms, 2½–3 inches long, living in the air passages of the lungs. They lay eggs that hatch before they pass out of the animal and reach the pasture as microscopic worms in the dung. These little worms have to grow in the dung for a minimum of five days before they are ready to continue their life in the unfortunate animal that picks them up ; they then reach egg-laying maturity in a month's time. Five weeks in all, therefore, is the minimum time for the complete cycle.

Conditions Conducive to Development

There are three important points to recall before attempting to explain the association between husk and intensive grassland management : first, that this parasite already exists on almost every farm where cattle are kept ; secondly, that the worms do not actually multiply within the lungs of a infected animal (all the eggs which they lay pass out with the dung) ; and thirdly, a heavy infestation is necessary for the production of severe disease. It will be obvious, therefore, that the success of the development of the young worms in their nursery on the ground will be a most important factor in the increase of their numbers in the herd. There are two important requirements for this development—*moisture* and *air*, or, more precisely, the

oxygen contained in the air. The climate that is particularly concerned is the " microclimate " down in the herbage and near the surface of the soil.

Thick and long herbage will ensure a moist microclimate, and there can be no doubt that the shade produced by the large leaves of Ladino white clover or of S.100 wild white clover will create an atmosphere that is saturated with moisture, in which even the surface of the dung will remain moist, and where the little worms can develop in maximum numbers. This contrasts markedly with the microclimate that exists on the surface of the ground under a reasonably short grass sward. In those circumstances a dry crust rapidly forms over the surface of the dung, and the little worms are shut in where the air cannot get to them so that they die from the lack of oxygen. The difference between the husk worm productivity under these two different conditions may well be a thousandfold, and we must conclude that deep, shade-producing herbage is a danger where husk is concerned.

Yet another undoubted danger lies in the frequent use of a chain harrow which, in spreading the dung (in a moist microclimate), brings about a greatly improved aeration and a better development of the worm brood. It may safely be stated from what is already known that, where dung lies as it falls, in one compact mass, it is only those larval worms near the surface that succeeded in their development : the great bulk of the little worms in the depth of the faecal mass are unable to grow. Spreading the dung, therefore, greatly increases the surface that is in contact with the air and, in a moist microclimate, helps the young worms to grow.

Habits and Length of Life It is still not very clear what happens to these little worms when their development in the dung has been completed—whether they are washed out by the rain or whether they actively migrate into the surrounding herbage. One point that seems to be fairly certain is that they do not readily climb up the blades of the grasses or the stalks of the clover leaves in the way that the young stomach worms certainly do. Investigations show that very few indeed succeed in climbing any higher than half-an-inch above the surface of the ground, where they appear to coil themselves very tightly and wait for the grazing animal to pick them up. This habit seems to have considerable significance in connection with the new practice of forcing the cows to graze these intensively-managed ley pastures right down to the surface of the soil. Presumably when the animals are grazing so closely they are picking up the maximum number of little worms obtainable from the pasture, and it may be concluded that here is another danger that may operate with particular force in the new practice of strip grazing by the aid of electric fencing.

A further point that should be mentioned before coming to recommendations for prevention concerns the length of time these little worms can live in the pasture, waiting for a grazing animal to pick them up. Little is known about this, but the indications are that they cannot survive nearly so long as can the young stomach worms. Our observations at Weybridge show that husk worms are found in the herbage in the greatest numbers within a few days of having completed their development on the ground, but that within a month most of them have disappeared. Whether they have descended again to the soil, or whether they have been washed off by rain we do not know, but whereas at the beginning of the observational period on our experimental plots we are able to recover them from the herbage in reasonable numbers, we are no longer able to do so after a month's interval.

Resistance of Adult Cows How do these several points apply to the recent widespread occurrence of husk in milking cows ? Our inquiries into the attending circumstances have repeatedly revealed an association with lush herbage, improved strains of grasses and clovers, the extensive use of fertilizers, and the practice of strip grazing. It used to be thought that the resistance to husk worms, such as is known to develop in young stock when once they have been infected, would be sufficient to protect adult cattle so long as they were maintained on a sufficiently high plane of nutrition ; but it is now clear that their resistance is not so strong as had been thought. It may be supposed that, although ordinary numbers are unable to establish a foothold in the lungs of adult cattle, a massive invasion of young worms may so lower the effective resistance of the lung tissue that it breaks down under the strain and the worms are then able to grow.

Some of our observations at Weybridge appear to support this view since we have been able to show the presence of considerable numbers of microscopic worms in the lungs several weeks, and in some instances two or three months, after the cattle were last exposed to infection. In the ordinary way (i.e., in a susceptible animal) these worms begin to lay eggs within a month of reaching the lungs, so that the retarding of their development suggests a resistance operating against them in the adult animal. As, however, worms are often found in successive stages of advanced development, it may be inferred that the resistance of the adult animals is in some measure being overcome by the invading parasites.

Recommendations Many of these points await proof by means of controlled experiments, but the probabilities seem sufficiently clear to warrant a few suggestions now that may help to avoid a repetition of the disastrous occurrence of the past wet year. These concern the provision of a break in the continuous use of high-yielding ley pastures. It will be seen from the foregoing that lush pastures, particularly if rich in clover, provide just the right conditions for husk worm development on the ground, that close grazing such as is enforced by the strip grazing technique ensures the maximum pick-up of young worms, and that excessive intake of young husk worms from the pasture breaks down the resistance of adult animals. If, therefore, the cattle go over the same ground two or three times, biting the herbage close and picking up the maximum number of young worms, putting down many more in the dung to be developed under the rapidly growing herbage, and again picking them up at the next round of grazing, there is a chance of their worm content becoming dangerously high. If, however, a part of the ley pasture, after having been grazed, is then reserved for the preparation of silage or of hay, there is a chance for the young husk worms to be reduced in numbers very considerably before that ground is used again. Furthermore, when the silage crop has been taken off and the cattle are grazed there once more, not only do they avoid the dangerous addition of more worms to the considerable number they may already have, but because of the respite from the continued attack of young worms endeavouring to establish themselves in the lung, they have an opportunity of putting their adult resistance into operation and of clearing themselves of what they already have. The use of the chain harrow should also be avoided, except in dry weather and when the herbage is short and the surface of the ground exposed : there can be little doubt that under these conditions it does nothing but good. Finally, where strip grazing is

practised the cattle should not be allowed to run back too far on to the parts they have already cleared.

The circumstances attending this kind of outbreak of husk resemble in many ways those attending the folding of sheep on arable ground, such as were first pointed out by the present writer in this JOURNAL in 1929.* The danger to the sheep (from stomach worms) under those circumstances is perhaps even greater than is the danger to cattle (from husk worms), because of the better climbing activity and the greater longevity of the young stomach worms. The exclusion of folded sheep from ground that they had occupied more than four days previously was shown to be a most important point, as by that time many of the young worms in the dung would be ready to infect more sheep. This prevention of animals running on contaminated ground may also be important for the control of husk in adult cattle.

To keep only one cow on four acres may insure against husk but it is poor farming, and a return to extensive grazing practices would be a retrograde step. This article is not intended to be a warning against the new developments in grassland management, nor is it a presentation of evidence against the greatly improved strains of grasses and clovers, all of which represent a very marked advance. Although it may be regarded as premature in that some of the points raised still need to be confirmed by careful laboratory observation, it is thought better to publish the tentative conclusions and so direct immediate attention towards promising remedial measures rather than to await the maturity of experimental proof.

Research Continues It cannot be pretended that the reasons for the widespread outbreaks of husk during the past year are thoroughly understood. Other factors that have not been mentioned such as the weather, or the disappearance of sheep from the dairy farm (alternate grazing with these animals is of great assistance in the removal of cattle husk worms from the pastures) may have played an important part. Parasitic worms, grazing animals and grassland are, however, inseparably linked, and it is not possible to make changes in the one without also affecting the others. Where new grassland developments are in progress, as they are at the present time, we must be alive to the dangers of increasing the worm population, and must discover the adjustments that are required for their control.

Research will go on in the hope that the health of grazing animals may be assured on these grand new leys.

* Stomach Worms in Sheep. E. L. TAYLOR. *J. Min. Agric.*, 1929, **36**, 31-8.

THE GRAZING OF KALE AND RAPE WITH CATTLE

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Some interesting information on the experiences of farmers in the grazing of cattle on brassica crops is revealed in this summary of the results of a survey which the N.A.A.S. recently carried out in south-western England.

HOW best to fill the gap between autumn and spring grass must of necessity be frequently uppermost in the mind of the stock farmer, and of the milk producer in particular. Next to grass and grass products, we are bound to rank kale a close second among stock feeds, not only for its cheapness per unit of food but for its considerable protein content. But the growing of good crops of kale involves a considerable amount of labour in the carting of dung to the field, hoeing and thinning the crop, and, above all, in cutting and carrying—often in extremely wet conditions. For these and other reasons, a number of farmers have adopted the system of taking the cattle to the kale. In view of the comparative newness of the idea, however, it is not surprising to find that several different techniques are being evolved.

In 1950 the National Agricultural Advisory Service in the South-Western Province carried out a survey of the practice of grazing kale and rape with cattle, partly to find out why more farmers had not been attracted to it, and also to learn more about the various methods used by the pioneers in this field. About a hundred farmers throughout the six south-western counties were asked for their experiences ; and it is to these farmers that we are indebted for most of the information summarized in this article.

The majority of these farmers had been following the practice for only two to four years, but several had done so for ten or more. In most cases, only dairy cows were grazed, but occasionally both store and fattening cattle were so fed. A wide range of conditions was represented—from farms at sea level to those at just on 1,000 feet ; from areas with an annual rainfall of less than 30 inches to others with more than 50 inches ; from light sandy or chalky soils to heavy clays. Indeed, it is interesting to note that on no fewer than twenty-two of the farms where cattle were grazing, these green crops were situated on heavy loams or on clays; and no less than twenty-seven were in districts with an annual rainfall of more than 40 inches.

The System : For and Against Many reasons were put forward in favour of the practice, but of these, the outstanding one and on which there was almost unanimity, was that it needed less labour. The majority claimed a higher output of winter milk because of the excellence of kale for milk production, coupled with the fact that at week ends the cows got more than if it were carted. On the other hand, most of them were agreed that the health of the cows was no better, and getting them in-calf no easier under this system ; indeed, there is some evidence that in one or two cases excess quantities of kale resulted in an unbalanced diet and irregular breeding.

A considerable number of the farmers liked the system because a crop of late-sown kale or rape could be taken in between a winter-sown crop of arable silage and a spring-sown crop, or after broken-up grass and before a spring-sown crop of corn or roots, thus enabling three crops to be taken

in two years. The treading of old turf or light land, the return of manure to the land without losses, and the ploughing-in of kale residues, had all proved invaluable preparation for succeeding crops.

Other reasons given were that it avoided the poaching of pastures to which cut kale would otherwise be carted, that it obviated the need for kale carting in hilly districts, and that cutting and carting kale in cold, wet weather could be dispensed with.

Asked why they thought more farmers had not adopted brassica grazing, a half maintained that the advantages of the system were not fully realized; that many lacked confidence in a new system and were waiting to see how others got on ; that they were not electric-fence minded ; or that they were unnecessarily afraid of the crop wastage. A quarter of the answers indicated that wet land and fear of poaching is a deterrent. Other interesting replies suggested that smaller farmers have insufficient acreage ; that individual animals cannot be properly rationed; and that there is still a prejudice in some quarters in favour of mangolds and other roots.

Among a considerable proportion of the farmers, the grazing of brassicas had raised no difficulties whatsoever. Poaching of the land was given as a drawback by nearly a half, although most qualified this objection by saying that it was of a temporary nature and not serious, except in wet years when the hauling of kale would present a problem anyway. Nevertheless, poaching was a very real problem for a few, either because of the difficulty in preparing seedbeds, because of the bad state of the land around gateways and on highway crossings, or on account of the dirty state of the cows. One farmer regularly planned three or four different means of access to the kale-grazing field.

Although a quarter of the farmers included wastage of crop as a drawback, nearly all thought the amount of food lost to be small, or that it did not matter because it was ploughed in for the next crop. Wastage was due to the tops being broken off and trampled in, to some of the foliage of extra heavy crops being spoilt before it could be eaten, or to the bottom part of the stalk being rejected by the cow. Several farmers used store cattle to clean up the stalks and other residues.

Again, about a quarter of the farmers had had fencing problems. For the most part they were users of electric fences, and had trouble only to begin with, or because of an individual animal persistently breaking out.

Asked how often stock had broken through the electric fence, thirty-two farmers replied, " Never " ; thirty-seven said, " Seldom " or " Rarely " ; eighteen, " Occasionally " ; and five, " Often." There was general agreement, however, that if the cattle were properly trained, especially when young, the electric fencing system was a good one. One or two farmers found it hard to get their workers to understand the need for insulation, a few complained of the breakages and replacements with wooden stakes, and several referred to the special difficulties involved in using electric fencing with tall crops of kale, which tend to sway on to the fence even when a path has been cleared for it. To counteract this, some farmers cut one or two rows ; others broke over the tallest plants. Other farmers switched over from early to late planting, and contented themselves with lighter crops, at the same time gaining the other advantage, already mentioned, of three crops in two years. Attempts to grow a single row of shorter brassicas such as cabbage or swede where the fence was to be erected were, on the whole, unsatisfactory.

A quarter of the farmers had experienced cases of blowing at one time or another. There was no indication that any particular type of kale or rape was less likely than another to cause this trouble, and no clear indication that the trouble resulted from any particular method of growing the crop. Usually, individual animals were prone to blowing. Most of the farmers who had had this trouble with their stock were confident that it could be overcome by keeping animals away from frosted crops and by feeding hay, straw and other roughage before turning in ; but these safeguards were not adequate in all cases. In one herd, blowing had been so serious that the grazing of brassicas had to be abandoned ; and in another the farmer resorted to wilting the kale. Perhaps it is only fair to add that on one of these farms blowing on leys had been a much greater problem.

The considerable interference with the grazing programme caused by frosty weather was also mentioned, and individual farmers referred to cows going lame through flints or kale stumps. Four or five cases of rape poisoning were also reported.

Choice of Crop and General Management A survey of the particular types of brassicas chosen for grazing showed that seventy-eight of the farmers preferred marrowstem kale ; forty-nine chose thousandhead kale ; twenty-six, rape ; fifteen, Hungry Gap kale ; and one, rape-kale. Combinations of two or more of those frequently provided successional grazing. The general tendency was for marrowstem kale to be succeeded after Christmas by thousandhead and Hungry Gap ; rape was fed both before and after Christmas. Mixtures of some of these types were sometimes grown, and turnips or ryegrass were occasionally added.

Although provision was made for a certain amount of brassica grazing during July–September and again in April (especially in Wiltshire), the most intensive grazing period was, as one would expect, from mid-October to mid-March, with the peak for the Province in December. In Cornwall, the peak was late January or early February.

Sowing dates ranged from March to August, with the peak in June. As already mentioned, some farmers who formerly sowed in April had changed over to June-July sowing. On the whole, drilling was twice as popular as broadcasting ; but in Gloucestershire and Somerset, broadcasting was in greater favour. One or two Cornish farmers mentioned the value of drilling on the ridge in high rainfall areas. Several farmers (particularly in Wiltshire) regularly broadcast or combine-drilled fertilizer with the seed ; but it must be pointed out that with combine drilling of brassica seeds the margin between success and failure is extremely narrow—depending on soil moisture and other factors—and the practice is not one which can be safely recommended. Rape, or rape and ryegrass, was occasionally undersown in cereal crops.

As might be expected, there was a marked tendency to do little or no thinning in these grazing crops ; firstly, to cut down the amount of work and secondly, because crops grown in this way were considered equally good or even better for grazing.

About two-thirds of the farmers dunged for these crops, and some of the others took their kale or rape after grass or a well-manured arable crop. Nitrogen is, of course, particularly important for high yields, and it is interesting to note that the amounts of sulphate of ammonia (or its equivalent) used varied from nil to 11½ cwt. per acre, with an average of 2 cwt. per acre. This very wide variation can no doubt be explained by the facts that late-sown crops could not be expected to make use of as much nitrogen as early-

sown crops, that previous cropping varied, and so on, but one gets the impression that additional nitrogen on some of the crops would have given better returns.

One-third of the farmers providing information were not prepared to hazard a guess as to the weight of crop per acre ; but the average estimated yield for the remainder was just under 20 tons, with a range of 5 to 40. This variation is not so strange as it may at first appear. On the chalk downs of Wiltshire and Dorset, land is relatively plentiful and the stock often range over comparatively light crops; whereas on the small farms, especially in the extreme south-west, land is scarcer so that, to produce heavy crops, early sowing coupled with heavy manuring would be the objective in many cases.

Grazing Technique Turning now to the details of grazing technique, Table 1 shows some of the variations in practice among users of electric fences :

Table 1

Variations in Grazing Technique using an Electric Fence

	Highest	Lowest	Average
Area of kale allowed per head per day (*square yards*)	70	2	13
Length of wire frontage per cow (*yards*)	8	4/5ths	3
Time taken to move fence (*man-hours*)	4	1/10th	5/6ths
Height of wire for adult stock (*inches*)	48	24	34

When grazing was controlled on a time basis, as opposed to an acreage basis, the time allowed varied from a quarter of an hour to continuous grazing day and night. When not grazing brassicas, the cattle were most often on a pasture field, but occasionally on a run-back in the brassica field.

By far the greatest number of farmers using electric fences moved the fence daily. Of the rest, most did so every second or third day and just a few favoured even longer intervals. Metal and wooden posts were equally popular, although there was a noticeable tendency to change from wood to metal. In either case the posts were normally erected about 10 yards apart, but there were three instances when the distance between supports was as great as 25 yards. Plain wire was far and away the most popular ; two wires were rarely used.

Bearing in mind the diversity of conditions and size of farms, it is not surprising that the figure for the acreage of kale or rape made available varied between 0.08 and 1.3 acres per head of cattle, but on average there was a fairly close affinity between the counties, as can be seen from Table 2. The size of herd grazed varied from 7 to 250; and the acreage provided, from 1 to 200.

Table 2

Number of Stock Grazed and Acreage Provided

	Average Number of Stock Grazed on Farm	Average Number of Acres of Kale and Rape Provided	Average Acreage per Head
Gloucestershire	36	17	0.5
Wiltshire	71	40	0.6
Somerset	31	10	0.3
Dorset	60	30	0.5
Devon	39	10	0.3
Cornwall	34	12	0.4
Entire S.W. Province	44	18	0.4

RECORDING GRAZING

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Cholsey Grange Farm has been managed for the last three or four years by Mr. R. P. Slade for Mr. and Mrs. G. N. Vansittart. During that time the production of arable crops, grass and milk, and the building up of a pedigree attested Ayrshire herd of quality have progressed steadily. The following facts and figures collected over many visits during May to November, 1950, speak for themselves on the all-important question of grazing production costs.

MANY of the farms in the area around Ibstone, Bucks, are on what is naturally an extremely poor soil formation, with steep chalk banks. Cholsey Grange is no exception, and in its original state could, in fact, be described as one of the poorest with some of the steepest banks. The total acreage is 240, and the policy is to plough every field in turn ; there is no permanent grass left on the farm. The rotation followed varies only with the length of the ley, and is usually wheat followed by a mixed forage crop, which is sometimes fed on the land and sometimes harvested, followed by barley and then a ley of one to five years' duration, dependent on the field and the stock requirements. The problem is not merely to grow good grass, but to grow any grass at all. Fortunately, the chalk banks are very free draining, and provided there is a crop, the cows can graze all the year round. They do, in fact, get about ten months' grazing in a good year.

An important feature of the holding is that the buildings are situated on high ground surrounded by some fairly flat land of the clay-with-flint type, which thins out to practically bare chalk on the slopes. Of the fields studied, Home Field, Old Barn, and Stoney Close (very flinty) are on the heaviest soil.

The Herd Although some cash crops are grown, the farm is geared to milk production, and of recent years the herd average has topped that of all other Ayrshire herds in the county. However, for the milk recording year ended September 30, 1950, it was narrowly beaten into second place.

The Chiltern Herd was founded before the war by the purchase of pedigree stock from well-known herds. More stock has been added subsequently, but a large proportion of the late entrants is home-bred and many of them have been sired by the senior stock bull, " Sheepcotes Enterprise ". He was one of the early purchases and has proved a great success, turning out a number of daughters whose milk and butterfat yields have been above average.

The National Milk Records results are as follows :

Year ended September 30, 1950

32 cow lactations	average yield, 11,124 lb.
10 first-calf heifer lactations	average yield, 8,833 lb.
Calving index	386 days

Total animals in herd — 34 cows, 15 first-calf heifers.

Highest individual yield during year

Burnockstone Princess 2nd .. .. 17,041 lb. (305 days) 5th calf 4 per cent B.F.

Age distribution	*No.*		*No.*
1st Calf	10	4th Calf	3
2nd Calf	13	5th Calf	2
3rd Calf	3	Over 6th Calf	11

Most interesting of all is the fact that the herd is commercially managed. There is no "boxing" of potential high yielders, no *ad lib.* feeding of concentrates, no policy of "milk at any price." Perhaps the "equal time" milking of 6 a.m. and 6 p.m. is not everywhere practicable, but where high yields are the aim it does avoid three-times-a-day milking. The whole herd is machine-milked and sets a very high standard in cow management without frills.

The Fields Studied Only those fields grazed by the herd since May 1, 1950, have been studied, so that the number is limited to five; and as two of these were usually treated as one, for practical purposes it is reduced to four.

Home Field (13.8 *acres*). An old pasture on the clay-with-flint soil ploughed and reseeded in mid-March, 1949. The cultivations were thorough but usual. The mixture sown was:

	per acre
Perennial ryegrass	16 lb.
S. 100 White clover	2 lb.
Barley	1 bushel

The barley was put in to provide an extra bite for the first grazing. At the same time, it was dressed with 3 cwt. superphosphate and 2 cwt. "Nitro-Chalk" per acre.

The opportunity was also taken to lime the field. Two tons per acre of ground limestone were put on by contract at the very considerable cost of £63 4s. 11d., allowing for the subsidy. As the clay-type soil is capping chalk, this dressing may be thought an extravagance, but it is a fact that, in these conditions the top soil can have a low lime status, and occasional liming when the field is ploughed is justifiable. The total estimated cost of the reseeding was £196 13s. 5d. but a proportion of this must be a charge on each subsequent year's grazing in the life of the ley. It is impossible to say how long the ley will last, but as this is unlikely to be less than three years, one-third, or £65 11s. 1d., was carried forward to 1950 as a proportion of the establishment cost.

The summer of 1949 was a dry one, so that there was little grazing, although by the winter there was sufficient ground cover for young stock to be run out. Three cwt. per acre of "Nitro-Chalk" was applied in the spring of 1950 and grazing began on May 1.

Old Barn and Stoney Close (12.1 *acres*). These two fields adjoin one another, and although during the first spring flush they were grazed separately, the herd was allowed to run over the two together for most of the season. The story is exactly the same as that for the Home Field with the same reseeding and fertilizing, plus an extra June dressing of 2 cwt. "Nitro-Chalk" per acre.

The Slipe (7 *acres*). This field, and its neighbour The Bank, lie close to the buildings and were at one time part of a 50-acre unfenced bank; both are on a north-easterly slope of thin soil. The Slipe was sown in 1949 with:

	lb. per acre
Canadian Grimm lucerne	16
Cocksfoot	2
S.100 White clover under oats	2

In 1949, the oats received 2 cwt. per acre complete fertilizer, and the young seeds 10 cwt. per acre basic slag. The spring dressing of 1950 was 2 cwt. complete fertilizer (15 per cent potash). On June 8, 1950, a cut of silage was taken and the field was ready for grazing on June 17.

The Bank (8 *acres*). This was an old, worn-out ley, heavily grazed during the winter of 1949-50 with young stock. It was ploughed in June 1950, and sown on July 1, with 7 lb. per acre rape-kale for grazing, and a timothy-meadow fescue-clover mixture. Fertilizing was at the rate of 2 cwt. complete fertilizer and 1 cwt. sulphate of ammonia per acre.

Cost per acre of Growing Grazing Crop, 1950–51

Home Field	*Old Barn*	*Stoney Close*	*The Slipe*	*The Bank*
£8 12s.	£10 1s.	£9 13s.	£5 10s.	£5 5s.

Utilization The electric fence was not used. The cows were allowed free-range grazing over a whole field, although it was unusual for the herd to be in one field for a whole twenty-four hour period.

Normally the period between going out after morning milking and coming in for evening milking was spent in one field, and the night in another. The expression "cow-grazing day" used below does not fit ideally into such a system, but by regarding the day-time as half a day and the night as half a day, a very fair indication is obtained of the rate of stocking, especially as, in this case, the fields had approximately the same grazing value.

The number of cow-grazing days is arrived at by multiplying the number of cows by the number of days they occupied a field, i.e., 10 cows for 2 days = 20 cow-grazing days.

Table 1

Field-by-Field Analysis of Cow-Grazing Days, 1950

Month	*Home Field*	*Old Barn and Stoney Close*	*The Slipe*	*The Bank*
May	627	551	—	—
June	760	304	76	—
July	461	550	89	—
August	341	217	403	—
September ..	210	480	46	120
October	—	—	—	352
Total	**2,399**	**2,102**	**614**	**472**
	174 per acre	173½ per acre	88 per acre	59 per acre

Production and Cost per Gallon The cow-grazing days do not distinguish between cows in full milk and those nearly dry, so productivity must be measured by the output of milk, which is most difficult to calculate accurately when concentrates are fed.

The feeding plan at Cholsey Grange is as follows :

Maintenance and first 30 lb. milk	Grass
Next 10 lb. milk	Cereals and brewers' grains
Over 40 lb. milk	Dairy nuts at 4 lb. per gallon

A handful of the brewers' grains mixture was given when the cows came in, and although it was probably negligible, 2 lb. of milk per day have been deducted from the grazing, which has, therefore, been credited in full with maintenance and 28 lb.

Table 2

Gallons of Milk Sold and Cost per Gallon from Grazing, 1950

Month	*Home Field*	*Old Barn and Stoney Close*	*Slipe*	*Bank*	*Sales from Grass*	*Gross Sales*
May ..	1,349	1,352	—	—	2,701	4,744
June ..	1,354	568	178	—	2,100	3,747
July ..	774	1,021	168	—	1,963	3,248
August ..	561	401	713	—	1,675	2,482
September ..	358	707	79	246	1,390	2,323
October ..	—	—	—	707	707	2,576
Total	**4,396**	**4,049**	**1,138**	**953**	**10,536**	**19,120**
Estimated Sales per acre ..	318	334	162	119		
Estimated Cost per gallon	6¼d.	7d.	8d.	10¼d.		

Gallons of milk refer to milk sales and not total production, which is usually slightly in excess of sales. As in the previous table, day and night have been considered of equal value.

Next, there is the comparison between the cost of grazing and the cost of the supplementary feeding.

The brewers' grains-cereal mixture varied slightly from week to week according to what protein cake could be bought, but the following is a fair average of its constitution.

	Cost s.	d.
75 lb. Wet brewers' grains	1	3
18 lb. Crushed oats	3	8
5 lb. Protein cake	1	3
2 lb. Mineral mixture		4
	6	6 per 100 lb.

6 lb. of this mixture was fed to all cows giving over 30 lb. milk per day, at a cost of approximately 5d. per head.

The price of the proprietary brand of dairy nuts rose during the period so, to avoid complication, an average of £29 per ton has been taken. Costs therefore were :

Grazing	7¼d. per gallon, including maintenance
Mixture	5d. per gallon
Dairy nuts	1s. 0¼d. per gallon

Cost of Providing Grazing Details of the expenditure on the initial establishment, and estimates of the cost of providing the grazing in 1950 in each of the fields studied were as follows :

Home Field (13.8 acres)

Establishment Cost, 1949	£	s.	d.	*Grazing Cost*, 1950	£	s.	d.
Cultivations	53	16	4		14	16	8
Seeds	40	13	8				
Barley	8	0	0				
Fertilizers	30	18	6		27	9	0
Lime	63	4	11	Rent	10	7	0
				Proportion establishment ..	65	11	1
	196	**13**	**5**		**118**	**3**	**9** = **£8 12s. 0d.** per acre

Cost to be spread over three years = £65 11s. 1d. per annum

Old Barn (6.8 acres)

Establishment Cost, 1949

	£	s.	d.
Cultivations	33	2	11
Seeds	20	0	6
Barley	4	1	7
Fertilizers	16	1	11
Lime	31	10	0
	104	**16**	**11**

Grazing Cost, 1950

	£	s.	d.
Cultivations and fertilizers	28	0	0
Rent	5	7	0
Proportion establishment	34	18	11
	68	**5**	**11** = **£10 1s. 0d.** per acre

Cost to be spread over three years = £34 18s. 11d. per annum

Stoney Close (5.3 acres)

Establishment Cost, 1949

	£	s.	d.
Cultivations	21	12	1
Seeds	15	12	8
Barley	3	3	7
Fertilizers	12	3	2
Lime	25	2	2
	77	**13**	**8**

Grazing Cost, 1950

	£	s.	d.
	3	8	11
	18	9	10
Rent	3	19	6
Proportion establishment	25	4	7
	51	**2**	**10** = **£9 13s. 0d.** per acre

Cost to be spread over three years = £25 4s. 7d. per annum

The Slipe (7 acres)

Establishment Costs, 1948-49

1948	£	s.	d.
Cultivations for oats	17	8	0
Fertilizers for oats	10	4	0
	27	12	0
Half cost carried to seeds	13	16	0

Grazing Cost, 1950

	£	s.	d.
Cultivations	2	17	2
Fertilizers	8	18	6
Rent	5	5	0
Proportion establishment	21	7	0
	38	**7**	**8** = **£5 10s. 0d.** per acre

1949			
Seeds (lucerne) undersown			
Cultivations	7	4	0
Seeds	24	6	0
Fertilizers	18	15	0
	64	**1**	**0**

Cost to be spread over three years = £21 7s. 0d. per annum

The Bank (8 acres)

Cost Apportioned to Kale, 1950

	£	s.	d.
Cultivations (June, 1950)	23	6	6
Half to kale *	11	13	3
Rape-kale	7	0	0
Fertilizers	16	14	0
	35	**7**	**3**

Grazing Cost, 1950

	£	s.	d.
Rent	6	0	0
Cost crop	35	7	3
	41	**7**	**3** = **£5 5s. 0d.** per acre

*As a seeds mixture was sown at the same time, only half the cost of cultivations is apportioned to the rape-kale.

Discussion of Results The term " gallons per acre " is now in common use, but its meaning is often far from clear. Frequently, it seems that the grass is credited with the entire production, regardless of the tons of concentrates fed. In this survey, the greatest care has been taken to leave with the grazing only what can logically be attributed to it. There is little doubt, in fact, that greater gallonage should be given to the perennial ryegrass leys of Home Field, Old Barn, and Stoney Close, as these were utilized during the month of May when the milk-stimulating effect of the pastures is at its height. If all the concentrates had been taken away at that time, production would have dropped to some extent, but the total could easily have been as high as 3,700 gallons, which would have added another 1,000 gallons to the pastures. This is not to suggest that the management was incorrect. The aim was high yields, and the total May sale of 4,744 gallons from 37 animals in milk was an exceptional achievement, as it represents an average sale of 4 gallons a day from every cow in milk. Very few herds of any breed are able to equal such productivity.

Another consideration is the possibility of a reverse effect, i.e., the production being sustained at a misleadingly high level by the use of concentrates. The experience of those who have previously watched this problem seems to be that it is the *quality* of the grazing that has the biggest, and certainly the quickest, influence on yield.

There is confirmation of this opinion here. From May 1 to June 16, all the grazing had been on the three ryegrass leys which it was intended to rest and dress with nitrogen. Accordingly, the herd was transferred on June 17 to The Slipe, where there was a fair growth following the cut for silage earlier in the month. For some unknown reason there was an immediate drop in yield, and the herd was not content on the cocksfoot-lucerne sward. Four days later, Mr. Slade had to return to his former routine of day grazing in Old Barn and Stoney Close, and night grazing in Home Field, or *vice versa*. There had been no change in feeding, but the yield recovered. The Slipe was rather disappointing throughout, and it was only from the end of July to the end of August, when it was continuously grazed by day, that it really pulled its weight. It is strange that lucerne, being a most successful crop on this farm, was not more productive, although it did, of course, produce a satisfactory crop of silage first.

Grass experts may consider the grazing of perennial ryegrass-clover leys during each of the summer months not quite " according to the book," but the wet weather and management combined to get growth almost continuously, which the herd invariably made very good use of.

The use of an electric fence might perhaps have increased productivity, but the case for using one is not nearly so strong where the herd numbers 35 to 40 as at Cholsey Grange, as it is with small herds of a dozen. By keeping the herd moving, Mr. Slade makes very good use of his grass and wastes very little.

Shorter grazing periods of from one to one and a half hours are used when grazing cereals and silage crops in early spring, and kale in autumn. The rape-kale on Bank Field was grazed by this method. The July-sown crop was put in simultaneously with a seeds mixture, and although there was a good take it is probably a mistake to have anything growing under kale, which is at its most valuable in November and December, and should normally be reserved for that period and treated rough. Mr. Slade had a large stock of silage on hand, however, and was able to begin full silage feeding at the end of October when the rape-kale was finished.

The conclusion is surely this : that expenditure of £10 per acre on providing grazing looks frighteningly high, but it can still lead to the cheapest means of producing milk.

Thanks are due to Mr. and Mrs. Vansittart for allowing many visits and inquiries, and to Mr. R. P. Slade for submitting his management to the test and making the facts available.

SCIENCE AND WATERCRESS GROWING

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A three-year investigation at Cambridge has found that the majority of waters used for irrigating watercress beds contain an abundant supply of all the major nutrients except phosphate.

AS Dr. H. V. Taylor points out in the foreword to the Ministry of Agriculture's Bulletin, *Cultivation of Watercress*(1), "little scientific investigation or research has been applied to watercress production, and the present methods and knowledge have been evolved by a process of trial and error." Before summarizing the results of a three-year investigation (1947–50) carried out at Cambridge with a grant from the Agricultural Research Council, mention should, however, be made of previous work by Barbier and Marcel(2) in France, and by Hamence and Taylor(3) in England.

Barbier and Marcel, as a result of their investigations, concluded that, while the irrigating waters were normally able to supply sufficient nitrate and potassium, the amount of phosphate was generally inadequate to meet the requirements of the plants under conditions of intensive cultivation. They were also able to demonstrate that waterborne supplies of phosphate could be supplemented by uptake from the soil on the bottom of the bed. In consequence, they recommended that phosphatic fertilizers were the most suitable for general use on watercress beds. The present investigations (see Tables 1 and 2) have similarly shown that in England, most waters used for watercress growing are also very low in phosphate, and it is interesting to note that, by trial and error, growers have found phosphates to be the only fertilizers to which watercress gives a good response.

Hamence and Taylor investigated the reason why watercress failed to grow on some relatively new beds at Wilsthorpe in Lincolnshire, and found that the failure was due to a deficiency of nitrate in the irrigating water. This has been confirmed in the present investigation, but it must be emphasized that Wilsthorpe is an exceptional case, and that in waters from all other districts there would appear to be adequate nitrate for normal growth.

Regions of Watercress Cultivation Commercial watercress cultivation is confined almost entirely to the southern counties of England, east of a line joining the Humber and the Dorset-Devon border, but excluding Norfolk and Suffolk. This distribution is restricted mainly because the growth of watercress depends on suitable

supplies of underground water. In the area cultivated, this can be obtained from the chalk, and, to a less extent, from certain other geological formations. Within the area, six main growing regions can be distinguished :

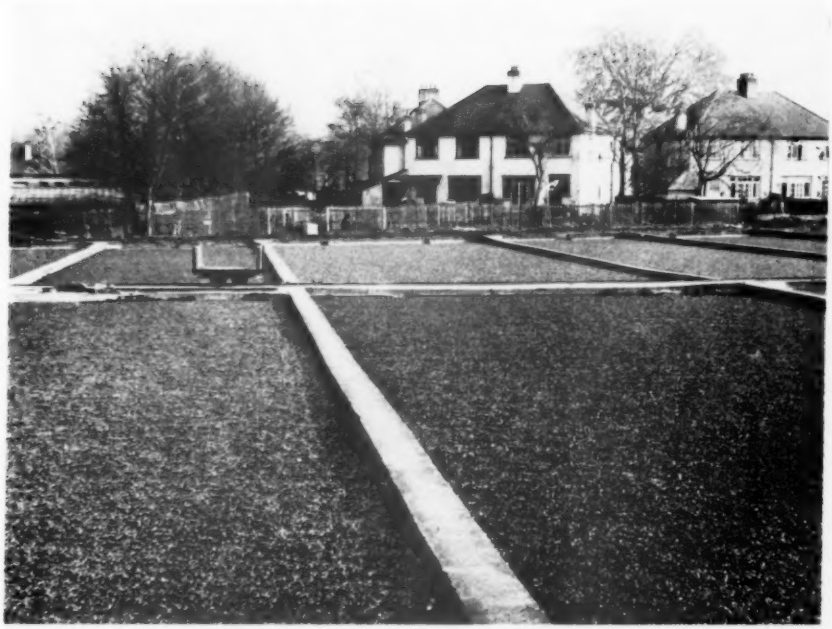
1. *The North Lincolnshire* group of sites. This, the most northerly region, is mainly of recent origin, although it is known that watercress was cultivated at Barrow-on-Humber before 1890. The beds are situated between the Wolds and the sea, and water supplies are obtained from the chalk.
2. *The South Lincolnshire* region, on the fringe of the Fens between Market Deeping and Bourne, where the beds are also of recent origin. Water is obtained from the Lincolnshire limestone, and, as is shown later, rather differs in character from the chalk waters.
3. *The Hertfordshire and Buckinghamshire* sites, of which there are a large number, including some of the oldest in the country. The beds lie on the north and west fringe of the London basin, and the water supplies are derived from the chalk.
4. *The East Kent and Surrey* group of sites, scattered along the southern fringe of the London basin, water supplies being obtained from the chalk and Lower Greensand.
5. *The Hampshire* region, which comprises one of the largest groups of sites, its water being supplied by the chalk of the Hampshire Downs and Salisbury Plain.
6. *The Dorsetshire and Wiltshire* region. Here, growers obtain water from the chalk and Upper Greensand.

Outside the main growing area, a little watercress is cultivated in Devon, South Wales, and in the Vale of Pickering in Yorkshire.

Survey of Waters For successful commercial cultivation, watercress differs from all vegetable crops in its dependence on continuous irrigation. It was decided, therefore, that the first thing to do in making a scientific study on watercress growing was to obtain information regarding the physical and chemical characteristics of the waters used. As has been previously mentioned, these waters are nowadays obtained almost entirely from underground sources, either natural springs or artificial bores, since it would be foolish to risk contaminating a salad crop like watercress with surface waters of doubtful purity.

On the whole, the waters examined proved to be remarkably similar in character. This is not altogether surprising since, as we have pointed out in the previous section, the great majority of waters come from the chalk. Since they were so similar, there is no point in giving individual results, and in Table 1 (Composition of Waters), only a single column has been used for the chalk waters of the five regions : North Lincolnshire ; Hertfordshire and Buckinghamshire ; Kent and Surrey ; Hampshire ; and Dorset and Wiltshire. In this table, where more than one figure per entry is given, the first figure is the lowest value and the second figure the highest value recorded. It can also be seen from Table 1 that the Lower Greensand water from Gomshall (Surrey) and the South Lincolnshire limestone waters differ in some respects from the more usual chalk type ; for example, the Greensand water contains relatively large amounts of phosphate, and the limestone waters relatively large amounts of sulphate.

It should also be noted that, no matter whether the test is made in winter or summer, the temperature of all waters at their sources is approximately 50°F., since, at depths of about 100 feet, they are of the same constant temperature as the earth at this depth.



Photos : *A. G. Lyon*

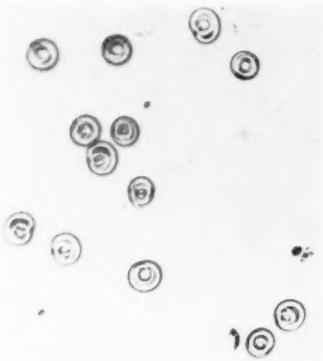
Top : Modern watercress beds in Surrey

Bottom : A Lincolnshire watercress bed. The worker is pushing cress into the water after the harvest has been pulled

Photos : *A. G. Lyon*

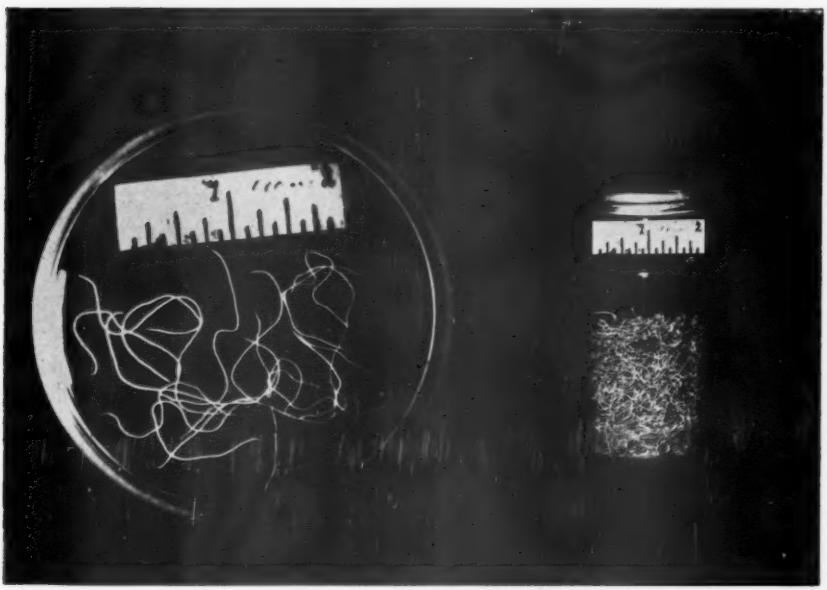
Top : Healthy watercress

Bottom : Watercress suffering from severe Crook Root



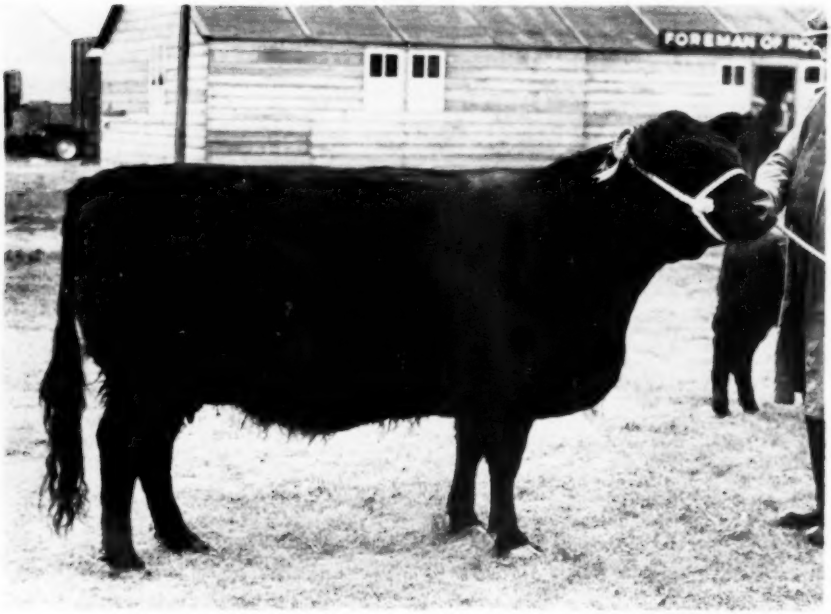
Tightly coiled third-stage larvae as they occur in the herbage (x75)

Larvae as they leave the infested animal and first reach the pasture (x75)

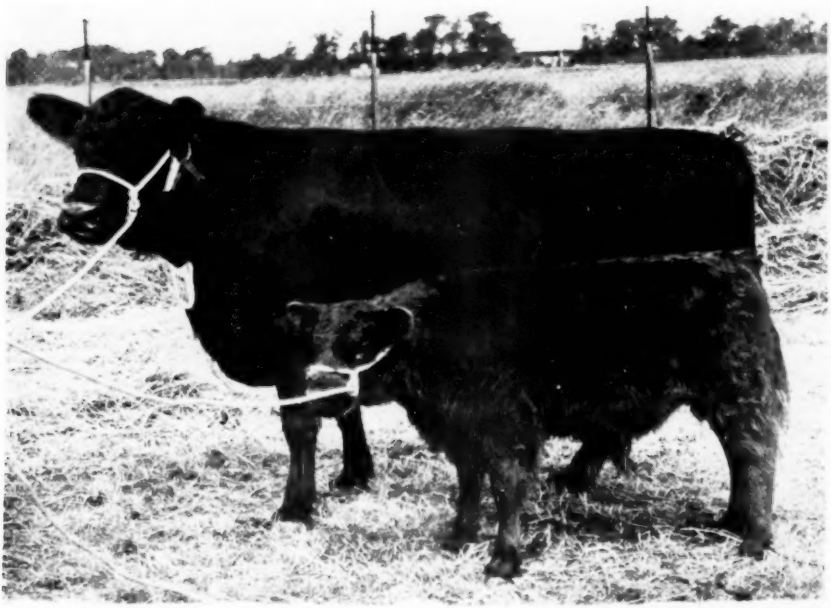


Left : Mature worms from air passages

Right : A collection of 1,324 worms taken from one animal which died from chronic husk



" Lorna 4th of Lochurr." First prize, champion and supreme champion, Royal Show, Oxford, 1950. Owned by Major T. W. Kennedy-Moffat, M.C.



Photos: *Sport and General*

"Lorna 3rd of Lochurr," with calf. First prize, champion and supreme champion, Royal Show, Cambridge, 1951. Also owned by Major Kennedy-Moffat, M.C.

Table 1

Composition of Waters used for Irrigating Watercress Beds

		Chalk Waters, N. Lincs ; Herts and Bucks ; Kent and Surrey ; Hants ; Dorset and Wilts *	*Lower Greensand Water from Gomshall (Surrey)*	*Limestone Waters from S. Lincs*
Temperature (deg. F.)		49.3 – 50.9	49	50 – 51.2
Oxygen (percentage saturation)		37 – 89	76	1† – 41
Carbon dioxide (mg./litre)		14 – 33	30	17 – 23
*p*H (electrometric)		7 – 7.4	6.6	7.2 – 7.4
Alkalinity (French degrees of hardness)		20 – 30	6.5	22 – 26
mg. litre = parts per million	Nitrogen in nitrate	1.6 – 7.9	3	0† – 3.9
	Phosphorus in phosphate	0.003† – 0.06	0.5	0.002† – 0.02
	Potassium	1.1 – 2.0	2.6	1.6 – 3.4
	Calcium	77 – 137	35	120 – 135
	Magnesium	0.5 – 4.5	1.5	5.5 – 8.5
	Chlorine in chlorides	12 – 35	18	22 – 24
	Sulphate	3 – 29	7	92 – 131
	(Iron (ferrous)	0†	0.2	0† – 0.4

* Also, one exceptional water from Hertfordshire (origin probably chalk) was found to contain 0.4 p.p.m. phosphorus in phosphate and 5.5 p.p.m. potassium—it was also only 22 per cent saturated with oxygen. Another water from the Upper Greensand in Wiltshire was found to contain 0.26 p.p.m. phosphorus in phosphate, although resembling in other aspects the chalk type.

† An approximate concentration. In the case of South Lincolnshire, one water may have been less than 1 per cent saturated with oxygen, and the same water may have had no nitrate or a very small concentration which was too low to detect. With phosphate, the lower figures are only approximate because of difficulties in estimating ; and with ferrous iron, concentrations less than 0.03 p.p.m. could not be detected by the methods used.

Amounts of Nutrients Available The relatively small values of the figures given in Table 1 may suggest that the water cannot furnish a very abundant supply of mineral nutrients to the crop ; for example, the concentration of nitrate nitrogen may be only about four parts per million parts of water. It should be remembered, however, that the amount of water passing through watercress beds is very large—some 300,000—500,000 gallons per acre per day has been suggested as an adequate amount. Taking the lower figure for the rate of flow, and four parts per million for the concentration of nitrate nitrogen, it can be calculated that the equivalent of some 73 lb. of nitrate of soda per acre per day (or rather more than 4½ cwt. per acre per week) may be supplied by the water. For phosphate, on the other hand, at a typical concentration of 0.02 parts per million (as phosphorus in phosphate), the figure would be very much less, at about the equivalent of ¾ lb. of 18 per cent superphosphate per acre per day (or 5¼ lb. per acre per week).

Table 2

Comparison of Watercress Waters with Culture Solutions

	Nitrate	*Phosphate*	*Potassium*	*Calcium*	*Magnesium*	*Sulphate*
Mean culture solutions	100	16	76	60	16	104
Average of 5 watercress waters from the chalk	100	0.47	38	2,820	56	250
Watercress water from the Lower Greensand	100	17	86	1,200	50	233

The amounts of nutrients may be considered in another way, as is shown in Table 2, where two types of watercress waters (it should be remembered that the Greensand water is an exceptional type) are compared on a ratio basis with the average of a number of balanced nutrient solutions recommended for hydroponics. The solutions recommended for hydroponics are from 100 to 200 times as concentrated as watercress waters, but the figures have been made comparable by taking nitrate as 100 in each case. It can be seen that the chalk waters contain very much less phosphate and considerably more calcium than is recommended for culture solutions, but that in other respects the two are comparable. The Greensand water, on the contrary, contains an adequate amount of phosphate, and it is interesting to note that phosphatic fertilizers are not used in this set of beds.

Bottoms of Beds So far, it has been assumed that water is the main source of mineral food, but it should be remembered that the crop is rooted in the soil or gravel of the bed bottom and is thus able to make use of whatever foods these substrates can provide. On the whole, it would appear that the substrate is less important than the water as a source of nutrients, and, in any case, that the substrate will, to some extent at least, be in equilibrium with the water. So far as nitrate is concerned, there would appear to be very little in bed bottoms since the waterlogged "soils" or silts are actively reducing and can destroy nitrate. The bed bottoms may, however, supply some phosphate, and it is also known that they provide the plant with iron made available in the ferrous condition by the reducing character of the "soil." Thus under circumstances where plants have failed to secure a roothold, or when gravel-bottomed beds have been well scoured of accumulated silt prior to replanting, a more or less marked chlorosis (yellowing) of the plants may develop. Such chlorosis does not, however, occur in the relatively uncommon cases of beds irrigated with waters containing appreciable traces of iron in solution.

Phosphate Manuring The traditional method of applying phosphate manures is to broadcast about 1–2 cwt. superphosphate per acre at different times during the growth of the crop (particularly after cutting or "pulling"), and afterwards to knock down the plants into the water so that the powder adhering to the leaves is washed off. After treatment in this way, analyses of outflow waters from beds have shown that, while a marked increase in phosphate resulted, it did not last for more than two or three days, by which time the concentration in the water had fallen to a level only slightly above that occurring normally at the inflows. It would appear, therefore, that a great proportion of the fertilizer is simply washed out of the bed and is thus not available to the plants, although, as Barbier and Marcel found, a small amount may be fixed and subsequently slowly released by the soil of the bed bottom. This probably accounts for the small but appreciable increases which were found by analysis to last for at least several weeks in the case of soft-bottomed beds. Seemingly, it might pay a grower with beds of this type to put superphosphate into the soil when they are dried off for replanting, since most of the fertilizer might be retained and made available to the plants over a longer period.

In the case of hard gravel-bottomed beds, however, where little or no "soil" may be present, the use of the less soluble basic slag is favoured by some growers. Superphosphate, when used on hard-bottomed beds, has to be applied with caution, as the risk of inducing a chlorosis is higher than in the case of soft-bottomed beds where the supply of available iron is probably less critical.

Change of Conditions Down a Bed As the water from a bore or spring passes down a bed, changes occur in such characters as temperature, amount of dissolved oxygen, amount of free dissolved carbon dioxide, and *p*H. So far as temperature is concerned, the water, after travelling for a distance determined by the rate of flow and the difference between inflow and air temperature, approaches the temperature of the air. Thus in one case, where the air temperature was 40°F. and the temperature of the water at the bore was 50.5°F., the temperature of the water was also 40°F. at 130 yards down the bed. It should be pointed out, however, that the change in temperature is not uniform, because the greater the difference between air and water temperature, the more rapidly is heat lost. In this way, loss of heat—and hence change in temperature—will always be greater in the upper half of a bed than in the lower half.

Table 3

Changes in Temperature and Dissolved Oxygen Concentration in Watercress Bed

	At the Spring	*Top of Bed, 28 yd. from Spring*	*5 yd. down Bed*	*10 yd. down Bed*	*End of Bed, 106 yd.*
Temperature (*deg. F.*)	50.3	51	52.9	54.0	69.5
Oxygen, percentage saturated ..	22	49	63	86	96

Another example of temperature change is shown in Table 3, where changes in dissolved oxygen concentration are also given. In this case, the air temperature was considerably higher than the temperature of the spring. It can also be seen that the water, in this instance rather low in oxygen, takes it up very rapidly from the air.

The amount of free dissolved carbon dioxide in the water decreases as the water flows down a bed. In one case it was present to the extent of 21 parts per million at the bore and progressively decreased to a value too low to detect by the time that the water had passed fifty yards down the bed. At the same time, due to this change in free dissolved carbon dioxide, the *p*H changed from 7.3 to 7.75, the water becoming more alkaline and less acid in reaction. This change in *p*H might be of importance in affecting the availability of trace elements such as manganese, but we have no evidence whatsoever that it is.

From the evidence available at present, it would appear that temperature is probably the most important of the factors which change as water flows down a bed, and it is, of course, well known that, in winter and spring, cress grows much better at the tops of beds where the water temperature is highest. It also appears that, for the same reason, relatively short beds are much better than long ones.

The *p*H and temperature changes can also be used to investigate the flow of water down different parts of a bed. On several occasions this has been found to be by no means uniform, and it would pay some growers to be more careful in seeing that the flow is as uniform as possible.

So far as nitrate is concerned, under normal conditions the differences in waterborne concentrations between the tops and ends of beds were found to be very small or not measureable. This is to be expected since, as we have pointed out earlier, very large quantities of nitrate (about the equivalent of 4½ cwt. of nitrate of soda per acre per week) are provided by the water. Changes in concentration of phosphate were often erratic, and in several

cases the water at the ends of beds were found to contain more than at the inflows—presumably due to the residual effects of manuring.

Crook Root Disease Although pests and diseases were not part of the research as originally planned, attention was soon directed to the apparently new and extremely serious disease of watercress for which W. C. Moore has suggested the appropriate name, "Crook Root." This disease appears to be caused by either one or two fungus species of the order Plasmodiophorales and has been investigated by D. M. Spencer of the National Vegetable Research Station. The writers[4] were able to suggest a few measures to alleviate the worst features of the disease, but a proper control can be attempted only when more is known of the life history of the organism—for which growers will have to await the results of the fundamental work now being carried out at Wye. A preliminary account of this work has, however, been published[5]. A card index of pests and diseases of watercress was prepared and a brief summary of these has been included in an account of watercress as a wild plant, which has been published in the *Journal of Ecology*.[6]

In this short article, it has not been possible to mention more than a few aspects of the investigation. More detailed accounts will, it is hoped, be published later in other journals.

This investigation was carried out while one of us (A.G.L.) had an Agricultural Research Council grant, the other author (H.W.H.) being a member of the Plant Breeding Institute, Cambridge. We should also like to express our thanks to all watercress growers for their generous co-operation and for placing at our disposal their practical knowledge and experience ; also, to Professor Sir F. L. Engledow who was mainly responsible for initiating the work, and for his interest during the course of the investigation.

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COLORADO BEETLE IN ENGLAND, 1951

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The numbers of single Colorado beetles and breeding colonies found in this country in 1951 were considerably less than last year—a decline partly attributable to adverse weather and the fact that the beetle is at present at a comparatively low ebb on the Continent.

A TOTAL of 170 single Colorado beetles and 29 breeding colonies were found in England during 1950, but careful observations in 1951 on the sites of these breeding colonies showed that all had been eradicated. Evidence was, however, obtained in April 1951, of the existence in Kent of one colony of beetles which had not been discovered in 1950, and which had overwintered there. Later in 1951, seven other breeding colonies and 83 single beetles were found.

Finds of Single Beetles Two Colorado beetles were reported in January 1951. The first—a live beetle—was found on January 16 in lettuce imported from Barcelona ; the second was a dead beetle which had been crushed between sacks of fertilizer. In February, two more live beetles were found on lettuce and endive imported from the South of France. No beetles were reported in early March, but during the four weeks from March 13, twenty-three beetles were found, most of them associated with imported fresh vegetables, particularly lettuce. Seven beetles were discovered in or on lettuce from Perpignan, and one was picked out of a crate which had just been emptied of lettuce from the same source. One more was found on imported Spanish lettuce, one on Italian lettuce, one on Italian cauliflower and one on French cabbage. The total also included a beetle found on fresh endive which arrived by air from Paris.

After the first fortnight of April there was a fall in the number of beetles found, and this probably reflects the embargo on certain vegetables, particularly lettuce from France, under the Importation of Plants Order. During the remainder of April and in May only thirteen beetles were found, and here again, in most instances, imported fresh produce appeared to be the source ; the total includes three beetles, possibly four, imported in lettuce from Holland, one of them in a consignment imported by air.

In June and July, nineteen beetles only were found, five of which were probably imported with horticultural produce ; one of these was with strawberries from France and two with apricots from Spain. There were no records of beetle flights from the Continent over the North Sea, and up to the end of July only ten beetles were found on ships, compared with thirty-five during the same period in 1950.

In August, twelve beetles were reported. Nine of these were traced to ships, docks and recently dispatched cargoes during the period when onions are imported in considerable quantities. Five were associated directly with Spanish onions and two were with cargoes (which included onions) from Holland and Belgium. Liverpool was again the main entry for onions and certain other cargoes from Spain ; five beetles were found at this port in 1951, as compared with eight in 1950. Prompt and thorough measures continue to be adopted in this area and arrangements are made for warning importers of any risks of beetles being transferred in produce from the Continent.

Four beetles were found in September and none in October or November. A further seven were found in December ; five of these were dead ones present in a jeep being shipped from Holland to South America via London. A live beetle was found on celery purchased at Ashton-under-Lyne market ; investigations of all possible sources showed that the beetle was probably one which arrived with imported lettuce or cauliflower. Finally, on December 27, a dead beetle was found on camomile flowers which had been imported from Belgium in the previous March.

A summary of the 1951 finds, compared with those of 1950, is as follows :

	1951	*1950*
Beetles associated with or on imported produce	41	54
On ships	17	49
Docksides and beaches	5	11
Inland on potatoes	0	12
Inland miscellaneous	8	33
Odd dead beetles	10	8
On aircraft	2	3
	83	170

From Scotland there were reports of four beetles. Two of these were found in April ; one dead in the back of a car that had been in France, and one live beetle which had probably arrived with imported produce. The other two were found in May and June in ships that had called at Continental ports.

Beetles Breeding The first evidence in 1951 of beetles breeding was a report received on April 24 from a farm near Pembury, Kent, of a beetle found when potatoes were being lifted ; the potatoes had been left in the ground over the winter because of flooding the previous autumn. An area around the spot where the beetle was found was injected with carbon disulphide, and a larger area round about was planted with a trap crop of potatoes. It was fortunate that this precaution was taken, because on June 14 and 15, eighteen more beetles and three batches of eggs were found on these potatoes. These were collected and all the potatoes were heavily dusted with DDT. No more beetles were found.

The second infestation to be discovered was on June 12 near Braintree, Essex, and it consisted of only one female and a number of eggs she had laid. The crop was thoroughly examined but no further signs of beetle could be found. The whole field was then thoroughly dusted with DDT.

Three colonies were discovered in Kent in July, one at New Romney, a second at Lamberhurst and a third at Dymchurch. The first was found on July 4 on field potatoes, and, in all, sixty larvae were discovered. A small area of potatoes was carefully lifted, the soil injected with carbon disulphide, and the surrounding potatoes dusted with DDT. The Lamberhurst case was a cottage garden ; sixty-five larvae were found on July 16 and the same treatment was adopted. At Dymchurch, conditions were quite different. In this instance one beetle and a number of larvae were found by workmen on July 20 on self-set potatoes in a 15-acre field of wheat. A plot of about 15 yards was cleared of wheat, and sixty-three larvae were found. The soil was very heavy and there were large drought cracks to a depth of about 18 inches, so that injection with carbon disulphide was not possible and thorough dusting with DDT was the only practical measure. There was a similar discovery at Hoo, Kent where, on August 18, twenty-six beetles in

all were found after the wheat had been cut. Very thorough dusting with DDT was done here, the whole field was carefully inspected, and a neighbouring field of potatoes, which had already been sprayed once, was re-sprayed.

In August a colony of larvae was also found in a 20-acre field of Home Guard potatoes at Waltham Abbey, Essex ; the larvae were noticed while the potatoes were being lifted on August 10. Eventually fifty-nine larvae were found, fourty-four on the haulm and fifteen by sieving the surface soil ; none had pupated. The area was injected as usual and the whole field thoroughly dusted.

The last discovery of the year was on September 14, when a single beetle was found beneath dying potato haulm on a small holding near Lancing, Sussex. Further search revealed only two more beetles, and it is likely that a number had already entered the soil for the winter. Injection with carbon disulphide was done in the spring because very wet conditions prevented the use of the heavy machine on this field in the autumn. Thus in all, eight breeding cases were discovered, and although some cases were straightforward and could be dealt with in a routine manner others were more complicated and emphasize the need for the services of trained entomologists to be quickly available.

Two of the eight colonies were found inside the area protectively sprayed but these were the colonies on self-set potatoes in wheat at Dymchurch and Hoo. The former was certainly not an overwintering colony, because only one beetle and its progeny were found at this site ; the latter could have been the progeny of a small overwintering colony but, to judge by the comparatively small numbers of beetles found, they are more likely to have been the progeny of a single beetle which had arrived on the self-set potatoes earlier in the season. Thus no colonies were found in 1951 on potato crops in the area protectively sprayed, and in 1950 only two of the twenty-nine colonies were inside this area. Once again no firm conclusions can be drawn but the figures suggest that the precautionary spraying campaign has been of very considerable value.

Planned Spraying and Dusting As in 1951 and the two previous years, a large area of potatoes was sprayed or dusted with DDT as a precautionary measure. The " protected area " was the same as in 1950, except that in Kent its southern boundary was extended to the Ashford-Redhill railway line (see map on page 131). Potatoes in fields around the 1950 breeding colonies were protectively sprayed as a routine measure. The mapping of all the fields to be sprayed was done by N.A.A.S. staff in the provinces concerned. The spraying and dusting campaign was chiefly the responsibility of Plant Protection Ltd. who, as in previous years, acted as agents for the Ministry. In addition to the precautionary spraying by ground machines, Pest Control Ltd. successfully sprayed by helicopter 910 acres around the port of King's Lynn between July 12 and 14 ; the daily acreages sprayed were 410, 403 and 97.

The ground spraying was considerably delayed because of late planting and delayed growth, but a start was made on early potatoes on June 4. Wet weather, especially during August, further delayed operations, but the campaign was completed by August 24, except for a little injection work.

Some 22,450 acres were sprayed and 4,590 acres dusted in the " precautionary " areas, and 470 acres sprayed and 155 acres dusted around the fresh occurrences. For spraying, a 25 per cent DDT emulsion was used, diluted 1 : 25 with water and applied at the rate of 10 gallons per acre. The aim was to apply 0.4 gallons of the emulsion per acre; the actual amount applied worked out at 0.43 gallons per acre. The 5 per cent DDT dust was applied at an average rate of 35.35 lb. per acre. A total of 4,095 fields were sprayed or dusted, compared with 3,926 in 1950. These were classified as follows :

Acres	No. of Fields	Percentage of Total
Under 2	724	17.68
2 to 5.9	1,610	39.32
6 to 10	1,026	25.05
Over 10	735	17.95

As in previous years, tractor and lorry drivers and field controllers were specially trained for the work, and the campaign was thoroughly planned beforehand.

The Outlook The fact that only eight breeding colonies were found in 1951, and none on potato crops in the area protectively sprayed, is evidence of the continued success of the campaign to prevent the pest becoming established in Britain. The beetle is at present at a comparatively low ebb on the Continent ; this fact and adverse weather conditions here and on the Continent have meant fewer beetles to cope with and fewer colonies to eradicate. However, in years more favourable to the beetle many more individuals may get across the Channel in various ways : some may be washed ashore, some will come on imported vegetables, and cross-Channel traffic of any kind is liable to harbour beetles. The Ministry must therefore continue to rely on the valuable support it has received from the public and all concerned with agriculture and horticulture. Particular thanks are due to the captains and crews of cross-Channel steamers and to merchants and retailers handling produce likely to harbour the beetle.

The Ministry also thanks the staff of Plant Protection Ltd. who, as in previous years, organized a very efficient spraying campaign, and Pest Control Ltd. for the successful helicopter spraying around King's Lynn. The help of the police has once again been invaluable ; their efficient and early reporting of the beetle has been an important factor in tracing the origin of single beetles.

The outlook for 1952 is reasonably good, but a year really favourable to the beetle may mean a reversal of fortunes. Any suspected occurrence of the Colorado beetle should be reported at once to the police, officers of the National Agricultural Advisory Service, or direct to the Ministry's Plant Pathology Laboratory, Milton Road, Harpenden, Herts. If a colony of grubs or beetles is found and reported, nothing more should be done until the arrival of an officer of the Ministry ; inexpert treatment might aggravate an otherwise straightforward occurrence.

GALLOWAY CATTLE

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THE district of Galloway which today comprises the counties of Kirkcudbright and Wigton is much less extensive than it was in ancient times. Centuries ago Galloway covered the western half of North Britain to the south of the Firth of Forth and included the counties of Dumfriesshire, Lanarkshire and Ayrshire. The province has given its name to two celebrated classes of stock—a breed of ponies and a breed of hornless beef cattle, but it is noteworthy that they were not numerous in any part of the area until about the end of the first quarter of the eighteenth century. Recurring feuds between the Scots and the English prevented any outlet south of the border, and cattle breeding at this period was not remunerative. It appears that about the year 1530 a cow was worth 2s. 2d. sterling ; an ox 2s. 6d. ; a two-year-old 1s. 1d., and a stirk 8d. It was more profitable to rear sheep than cattle, their principal value being wool, for which there was

a steady demand at fair prices. Both the highlands and those arable areas, not actually under a crop, were stocked chiefly with sheep. At the close of the eighteenth century and early in the nineteenth between 20,000 and 30,000 three- and four-year-old Galloway cattle were sent from the lush pastures of Dumfriesshire and Galloway to England. Norfolk and Suffolk were good customers.

Galloway cattle have been popular in Cumberland and Northumberland for many years. This is not surprising, for in distant times the border county was under the same rule as that part of Scotland lying immediately to the north of it. Cattle thieving was common among the borderers in those days. The following was as true of the borderers as of the folk in Rob Roy's country :

The good old rule
Sufficeth them ; the simple plan,
That they should take who have the power,
And they should keep who can.

From time to time large numbers of Galloways have been exported to both tropical and temperate climates (principally the U.S.A. and Canada), and wherever they have gone they have been given good reports. In Ireland they have done extremely well, particularly improving the quality of the store cattle. On inferior land no breed will do better than the Galloway. They adapt themselves well to most climates, and are often found on exposed uplands where no other class of cattle can thrive.

Hardy Stock producing Good Beef

The wet and rough weather conditions found in Galloway have evolved a race of hardy animals which are happy beneath open skies and in unsheltered, open spaces. The moist climate is responsible for the thick and rather long outer coat of fine hair which it has been said " acts like a thatch in throwing off rain." The cold has produced a dense undercoat, abundant and soft, and practically impenetrable. This effective shield against the severe climate is the outcome of continued natural and artificial selection. Galloway cattle are specially fitted for winter ranging in the open almost anywhere. In spring the outer coat is cast, and the soft, brown, undercoat is then readily seen : this is not shed until summer. Judges look at the undercoat for indication of a thriving animal with natural fleshing and milking qualities. The prevailing colour of the coat is black. Records of successes in the Smithfield carcass competitions are sufficient proof that Galloway cattle are capable of producing beef of the finest quality.

One of the oldest pedigree herds in the country is owned by Sir John W. Buchanan-Jardine, Bart. It contains the very best blood and has won leading honours at all Breed and Fat Stock Shows—The Royal, The Highland, Smithfield, and Edinburgh. On the high-lying farms of Barlae, farmed by Mr. O. B. M'Turk, cattle have been bred since 1832, and the first cow registered in the Herd Book was calved in 1866. Today, the herd of cows continues to breed hardy cattle that are able to forage for themselves most of the year. Another outstanding pedigree herd is owned by Mrs. Murray-Usher. Bred and kept in natural surroundings at Murraytown, Gatehouse-of-Fleet, the herd of over 70 blacks and duns has all the qualities of hardiness and thriftiness connected with the breed.

The Galloway Herd Book

All registered Galloways are tattoed with their Herd Book number in the right ear. In 1877 the Galloway Cattle Society was formed for the management of a Herd Book

solely for the Galloway breed. Today, the members number about 270. It is more than twenty years since the Herd Book was closed. Only the progeny of registered cattle have been eligible for entry. But the Council now operates an Appendix Scheme, whereby the descendants of pure-bred, but at present unregistered Galloway cattle, may later become eligible for entry in the Galloway Herd Book. Only black and dun Galloways can be entered in the book. The Belted Galloway is a distinct strain and has its own Herd Book.

GRADING AND INSPECTION OF FRESH FRUIT AND VEGETABLES IN THE U.S.A.

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This article is a summary of impressions gained by the writer during a trip to the United States in the summer and autumn of 1951. The visit was arranged by E. C. A. to study the Fresh Fruit and Vegetables Inspection Service of the U.S. Department of Agriculture.

THE United States Department of Agriculture started to issue standard wholesale grades for fresh fruits and vegetables at the end of the first world war. At the same time an inspection service, operating in large wholesale markets, and charging fees, was established. The Inspection Service provided certificates giving full and unbiased information on the quality and condition of consignments of produce. The need for such standards and inspection facilities was brought about primarily by the opening up of new producing areas in the West which sent produce to eastern markets two to three thousand miles away. This change from local to long distance dealing created many marketing problems and made the development and use of definite and universal standards of quality very necessary. For a short time this market inspection service was available only to senders of fruit and vegetables ; subsequently it was extended to anyone with a direct financial interest in the produce. A few years later the Federal and State Governments co-operated to set up an inspection service in production areas. This " shipping point service," as it is called, completed the inspection chain.

The Certificate and its Uses The certificate issued by the Inspection Service is designed to give the fullest possible information about the produce inspected. For example, a typical certificate on a railway truckload of apples will describe the type of truck, method of stowing the boxes, show the temperature of the stored fruit, name of the variety, number and type of package used (including full details of the package markings), and a full description of the method of packing the fruit, with particular reference to wrapping, container linings, and general standard of the packs. This is followed by three further sections dealing with the "size"; "quality," under which the more or less permanent properties as colour, shape, cleanliness and freedom from defects, are described ; and "condition," where such progressive factors as maturity, freshness and decay are mentioned. Finally, a statement is made on the grade of the fruit. If a considerable proportion

of apples is of a higher grade than that actually claimed this fact is also shown.

Except where an applicant asks for an inspection to be confined to one particular factor, such as size or amount of decay present, a detailed certificate of the kind described above is always given.

The use of United States grades and of the inspection service has always been voluntary, except under certain special circumstances which will be referred to later. Despite the absence of legal compulsion, however, the advantages to both seller and buyer of using specific grades when selling by description on a contract basis, or for comparing prices at different markets, led to their rapid adoption. The value of certificates of quality and condition of graded produce when sending to new markets, or for settling claims between seller and buyer, or with carrying companies, made the use of both the grades and inspection certificates integral parts of the distributive system.

One important change resulting from the increased use of grades and certificates in trading has been a marked reduction in consignment for sale on commission and a corresponding increase in firm sales on grade description. The grower then knows the price he is getting for the produce before it is dispatched. In addition, the State and Federal Agricultural Departments maintain regular market price broadcasting services, in which U.S. grades are used as a basis.

Inspection in Production Areas The shipping point inspection service can be in many ways of great value to the grower. For instance, by paying a few dollars to have a load of produce inspected he obtains a certificate which is accepted by all Federal courts as *prima facie* evidence of the quality and condition of his produce. Consequently, if he has a contract with a buyer to deliver a load of produce of a certain grade, he has the satisfaction of knowing that if the produce is certified as meeting that grade he is "insured" against unjust rejection of the consignment by the buyer. Many large organizations like to have an inspector permanently attached to their packing houses. He is immediately available to certify loads of produce and, although he is not there in an advisory capacity, he can frequently give valuable information on the grading, packing and loading processes. It is also well known that the mere presence of an inspector in a packing house markedly improves the standard of grading and packing by the workers. Inspections of loads may be made in dispatch bays, cold stores, or in loaded rail wagons or lorries. Generally, the last two points are preferred, since subsequently the load can easily be identified by reference to the wagon or lorry registration numbers.

Another important field in which the shipping point inspection service has proved of value to growers is that in which the produce is intended for canning or processing. Experience has shown the seller and the buyer that the best form of contract is one based on the special U.S. grades which have been laid down for fruit and vegetables for processing. Before the season starts, canners and growers agree prices for different grades, and as each load arrives at the processing plant it is sampled by an inspector who issues certificates, showing the percentage of each grade in the load, to both the grower and the canner. Payment is made on this certificate. This system, whereby an unbiased report is secured, satisfies both parties ; it provides a direct incentive to the grower to deliver high quality produce from which the processor can make a top quality product, and can also save countless arguments between the interested parties. In many States more produce is inspected for processing than for direct sale on wholesale markets.

Most canneries provide special facilities for inspection work. The inspector's samples are placed on a grading table, and the specimens sorted according to the grade in separate compartments. At the end of the assessment the table is tipped and the graded produce falls into buckets resting on scales ; the proportion of each grade in the sample is thus easily computed.

Many States have legislation which allows growers to conclude a general agreement on the restriction of the sale of any commodity in time of glut or when such action is considered necessary to maintain the reputation of the produce of that State. The easiest way for such agreements to be operated is on the basis of U.S. grades, and in order that a growers' association operating an agreement can keep a check on consignments, the inspection service is used to examine each load marketed and, where it complies, to certify that it is of the required standard.

Another advantage of the scheme is that certificates on reasonably non-perishable products such as potatoes, onions or apples are accepted by many banks as security for loans ; the inspection service is often used for this purpose.

Production point inspectors, although trained by the U.S. Government, are actually employed by the States in which they work. Very few spend all their time in one State. Thus an inspector may spend the winter in Florida inspecting lettuce, beans and other vegetables, then move north in the spring to the Carolinas to examine strawberries. From June to August he may be in New Jersey working on cannery tomatoes, moving on to Pennsylvania and Virginia until November to cover the apple crop, and finally returning to Florida for the winter.

Inspection in Wholesale Markets Market inspectors, unlike their shipping point counterparts, are employed by the U.S. Government, and stationed permanently in large cities. They are frequently called on by buyers to examine and certify produce on arrival in the wholesale market. The buyer may consider that the produce does not come up to the agreed standard of the contract, and may wish to safeguard himself by getting an inspection certificate before rejecting the consignment. The produce may appear to have suffered damage in transit, and again it is to the buyer's advantage to obtain a certificate to confirm this before taking up the matter with the carrier. Occasionally, a buyer may disagree with a grade certificate given at the shipping point, and may appeal against the grading. In such a case the produce is examined by more than one inspector before a decision as to grade is reached. If the shipping point grading is reversed, the applicant pays nothing for the inspection ; if the grade is upheld, a double fee is charged. It is a tribute to the efficiency of the U.S. Inspection Service that appeals against shipping point grading are rare, and reversals of grade even rarer. In 1951, out of an equivalent of 817,000 rail trucks inspected at production point, only 252 (0.03 per cent) reversals were made.

Market inspectors also carry out other important kinds of assessment. Many chain stores and other large retail enterprises contract to buy produce packed to U.S. grades, and use the inspection service to check the quality and condition of their purchases ; this again is a form of insurance against loss. Many steamship companies purchase their supplies of fruits and vegetables by tender on the basis of U.S. grades, and inspectors work either at the docks or in salesmen's warehouses checking the quality and net weights of the produce supplied. Government agencies, e.g., the Army, Navy, Marine Corps and Veterans' Hospitals, purchase supplies in the same way,

again using the Inspection Service as an impartial authority. In each case, the fact that a decision as to quality can be given on the spot is extremely valuable with highly perishable produce, and may well save endless wrangles between seller and buyer.

A further useful function performed by market inspectors is in disputes which may arise between buyer and carrier on questions of damage in transit due to faulty loading or handling of produce. Where it is desired to save long arguments and litigation, an inspector may be asked to determine, using methods already agreed between carriers and the U.S. Department of Agriculture, whether the damage is incidental to normal hazards of transport, or the result of bad handling by the carrier : his report is accepted by both parties.

Many market inspections are made in the railway wagons in which the produce is transported. These wagons, which may be in sidings in such cities as Chicago, or on large ferries on the Hudson River in New York, are frequently cooled by ice placed in bunkers at the end of each wagon, and in some cases crushed ice may also be spread among the packages. Inspections may also take place in salesmen's warehouses, at the docks, and in retail stores.

Compulsory Certification Inspection and certification are compulsory in certain circumstances. From time to time Government " support prices " or subsidies are paid on some crops, and these are always based on U.S. grades. To obtain a payment of this kind on any produce, the claim must be accompanied by an inspection certificate. In addition, no fruits or vegetables can be exported from the United States without inspection and certification. This does not just guarantee that only high quality produce is exported, but also certifies that the products are free from certain pests (codling moth, or San José scale, for example) which must be declared absent under the phytopathological regulations of some importing countries.

Some States have special laws concerning the packing, grading and branding of produce for sale in that State, and in certain instances it is compulsory for all fruit and vegetables sent to other States to be properly graded and packed, either to U.S. or State grades, and inspected before it crosses the State border. This is regarded as necessary in order to maintain the reputation of the produce grown in that particular area.

The Federal Inspection Service is not, to use the American term, "regulatory" in nature ; that is, it has no power to take action in cases involving fraudulent practices in fruit and vegetable trading. To prevent such practices, however, an Act, known as the Perishable Agricultural Commodities Act, was passed in 1930, and under its provisions all dealers who handle fruit and vegetables must be licensed. Failure to pay for, or unreasonable rejection of, produce received on consignment, or changing the contents of a load after inspection, are punishable under the Act, and the Department of Agriculture will, without charge, assist a party to a contract in obtaining redress, either by arbitration or legal action. If a violation is proved, the Department will publish the facts, and either fine the offender or revoke his licence. Such service could be provided only on the basis of standard grades and the Inspection Service, and, indeed, the certificate of inspection frequently provides all the evidence required for the settlement of a dispute under this Act.

GRADING AND INSPECTION OF FRESH FRUIT & VEGETABLES

The Extent of the Service The rapid increase in the use of the U.S. Inspection Service since its inception shows its value to the fresh fruit and vegetable distributive trade. There are now shipping point services in all forty-eight States, and receiving market offices in fifty-four large cities. In 1951, the equivalent of 1,335,884 rail-car loads were inspected ; this total included 860,000 cars for ordinary commercial uses, 350,000 for processing plants, and nearly 50,000 (or $2\frac{3}{4}$ million tons) for public and private agencies. The principal commodities inspected for commercial uses are potatoes, apples, citrus fruit, peanuts and onions; at processing plants, the most important products are tomatoes, citrus fruits, sour cherries, grapes and apples.

Consultations are constantly taking place between the Department of Agriculture, growers' organizations, and wholesale and retail buyers, to revise old grades or establish new standards, and much work is being done at the present time on "consumer" grades for pre-packed fruit and vegetables. These latter grades are of particular value to the retail trade and indicate that the United States Department of Agriculture is fully aware of the importance of its services to the final judges of produce, the consumers. The Department claims, in fact, that the consumer has benefited from the improvements in marketing brought about by the effective use of national grades and an impartial grade assessment service.

AGRICULTURAL INDEX NUMBERS

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS

INCLUDING EXCHEQUER PAYMENTS (UNCORRECTED FOR SEASONAL VARIATION)
BASE 1927–29=100

	1952			1951		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
All Products	307*	292*	278*	279	276	262
Cereals and Farm Crops	281	278	278	249	254	260
Livestock and Livestock Products	315*	297*	277*	290	283	263
Wheat	285	285	289	276	276	281
Barley	394	363	328	319	323	323
Oats	319	307	308	248	250	250
Potatoes	225	235	248	204	214	223
Hay	244	246	236	265	256	252
Fat Cattle	244	255	261	210	222	228
Fat Cows	199	210	215	172	180	184
Fat Sheep	233	245	245	214	227	235
Fat Ewes	218	224	233	200	206	215
Bacon Pigs	348	349	348*	312	313	314
Pork Pigs	298	298	298	269	269	269
Sows	238	238	238	228	228	228
Milk	359*	337*	309*	338	321	295
Butter	143	143	143	114	114	114
Poultry	293	279	272	292	299	302
Eggs	293	235	197	248	248	193
Store Stock†						
Dairy Cows	207	206	197	181	183	181
Store Cattle	216	229	242	203	210	214
Store Sheep	244	263	275	208	231	243
Store Pigs	378	388	400	383	406	419

* Provisional.

† Not included in general index.

AGRICULTURAL STATISTICS
ENGLAND AND WALES

June, 1951, Agriculture Returns (Final)

CROPS AND GRASS

(thousand acres)

DESCRIPTION	1939	1950	1951
Wheat	1,683	2,398	2,060
Barley	910	1,624	1,733
Oats	1,358	1,835	1,642
Mixed corn	83	827	826
Rye, for threshing	(b)	67	51
Beans, for stock-feeding	133	109	103
Peas, for stock-feeding	37	37	33
Potatoes, first earlies	56	183	137
Potatoes, main crop and second earlies	398	683	595
Total potatoes	**454**	**866**	**732**
Turnips and swedes for stock-feeding	396(c)	300	306
Mangolds	210	267	255
Sugar beet	337	419	415
Rape	53	132	133
Cabbage, kale, savoys and Kohl Rabi, for stock-feeding	94	233	247
Vetches or tares	49	36	30
Mustard, for seed, fodder or ploughing in	48	28	59
Linseed	4	38	27
Flax, for fibre		17	23
Hops	19	22	22
Orchards with crops, fallow, or grass below the trees	236	260	263
Orchards with small fruit below the trees	18	13	13
Small fruit, not under orchard trees	29	38	35
Vegetables for human consumption (excluding potatoes), crops under glass, and flowers	275	517	431
Fruit and vegetables, not grown primarily for sale	(b)	10	9
All other crops	48	37	41
Bare fallow	355	260	377
Lucerne	32	74	84
Temporary grass (including clover and sainfoin) for mowing	1,304	2,103	2,324
Temporary grass (including clover and sainfoin) for grazing	768	1,382	1,407
Total temporary grass	**2,072**	**3,485**	**3,731**
TOTAL ARABLE LAND	**8,935**	**13,949**	**13,680**
Permanent grass for mowing	4,612	2,755	2,827
Permanent grass for grazing	11,097	7,742	7,959
Total permanent grass	**15,709**	**10,496**	**10,786**
TOTAL ACREAGE OF CROPS AND GRASS (a)	**24,643**	**24,445**	**24,466**
Rough grazings —Sole right	4,179	3,968	3,939
" " —Common	1,361	1,502	1,504
Total rough grazings	**5,541**	**5,471**	**5,443**

(a) Excludes rough grazings.
(b) Not separately returned.
(c) Includes turnips and swedes for human consumption.

SMALL FRUIT, VEGETABLES, CROPS UNDER GLASS AND FLOWERS

(thousand acres)

DESCRIPTION	1939	1950	1951
Strawberries	18.7	21.1	17.5
Raspberries	4.1	4.3	4.3
Currants, black	10.4	16.0	15.9
Currants, red and white	2.3	1.9	1.6
Gooseberries	9.1	6.7	7.0
Loganberries and cultivated blackberries	2.5	1.2	1.2
Total small fruit	**47.2**	**51.2**	**47.6**
Brussels sprouts	38.0	43.9	40.6
Remaining spring cabbage (planted in previous year)		7.1	13.4
Summer cabbage		15.3	9.8
Autumn cabbage		8.1	6.0
Winter cabbage	44.1	16.4	13.2
Autumn savoys		5.2	3.7
Winter savoys		13.1	10.4
Kale and sprouting broccoli		2.6	2.2
Cauliflower or broccoli (heading)	18.9	24.6	23.8
Carrots	16.1	30.8	24.2
Parsnips	(b)	4.9	3.5
Turnips and swedes	(c)	7.1	6.0
Beetroot	(b)	8.1	7.4
Onions grown for salad	1.7	1.4	1.2
Onions for harvesting dry		5.4	3.6
Beans, broad	17.8	5.9	3.9
Beans, runner and French		10.9	8.5
Peas, green for market	60.6	54.6	40.3
Peas, green for canning or quick freezing (a)	28.0	24.7	23.1
Peas, harvested dry		153.4	116.8
Asparagus	2.6	1.7	1.8
Celery	6.7	5.1	4.2
Lettuce	5.9	8.5	8.2
Rhubarb	7.2	9.4	9.0
Tomatoes (growing in the open)	0.2	2.0	1.7
Other vegetables	(b)	19.6	16.3
Total vegetables (excluding potatoes) grown in the open	**247.7**	**489.7**	**402.8**
All crops grown under glass	**3.3**	**4.7**	**4.6**
Hardy nursery stock	10.5	10.5	10.4
All bulb flowers, not under glass	7.7	5.3	6.2
Other flowers, not under glass	5.8	6.8	7.3
Total flowers grown in the open	**24.0**	**22.6**	**24.0**

(a) In 1950 and earlier years returned as "Peas, green for canning."
(b) Not returned.
(c) Not separately returned, included with turnips and swedes for stock-feeding.

LIVESTOCK

(thousand head)

DESCRIPTION	1939	1950	1951
Cows and heifers in milk	2,255	2,448	2,370
Cows in calf but not in milk	392	503	490
Total	**2,646**	**2,951**	**2,860**
Heifers in calf, with first calf	459	674	655
Bulls for service	91	95	89
Bulls (incl. bull calves) being reared for service	43	40	34

LIVESTOCK (*thousand head*) *contd.*

DESCRIPTION	1939	1950	1951
Other cattle two years old and over :			
Male (steers)	(a)	476	520
Female	(a)	667	709
Total	**944**	**1,144**	**1,230**
Other cattle one year old and under two :			
Male (steers)	(a)	406	446
Female	(a)	1,038	1,061
Total	**1,346**	**1,444**	**1,507**
Other cattle under one year old (excluding bull calves being reared for service) :			
Male (steers)	(a)	475	447
Female	(a)	1,192	1,091
Total	**1,242**	**1,667**	**1,538**
TOTAL CATTLE	**6,770**	**8,014**	**7,912**
Sheep one year old and over :			
Ewes for breeding	7,160	4,681	4,759
Two-tooth (shearling) ewes	1,477	1,175	1,226
Rams for service	205	132	134
Other sheep one year old and over :			
Male	1,021	590	1,282
Female		410	
Total one year old and over	**9,863**	**6,989**	**7,401**
Sheep under one year old :			
Ram lambs for service	156	69	68
Other sheep and lambs	7,967	5,319	4,984
Total under one year old	**8,123**	**5,388**	**5,052**
TOTAL SHEEP AND LAMBS	**17,986**	**12,376**	**12,453**
Sows in pig	(a)	143	200
Gilts in pig	(a)	78	127
Other sows for breeding	(a)	86	123
Total sows for breeding	**449**	**307**	**450**
Barren sows for fattening	(a)	13	14
Boars for service	30	19	25
Young boars being reared for service	(a)	9(8.5)	11(11.1)
All other pigs :			
Five months old and over	633	597	708
Two to five months	1,516	772	1,047
Under two months	888	496	712
Total all other pigs	**3,036**	**1,865**	**2,468**
TOTAL PIGS	**3,515**	**2,212**	**2,967**
Fowls :			
Six months old and over	23,154	28,731	28,622
Under six months old	29,758	32,781	34,863
Total fowls	**52,912**	**61,512**	**63,484**
Ducks, Total	**2,237**	**2,246**	**1,760**
Geese, Total	**584**	**801**	**606**
Turkeys, Total	**693**	**753**	**734**
TOTAL POULTRY	**56,426(b)**	**65,312**	**66,585**

(a) Not separately returned.

(b) As a result of war-time controls many small sized holdings were recorded for the first time in 1941. It is estimated that to make the totals prior to 1941 reasonably comparable with later years some three to four million birds should be added in England and Wales.

LIVESTOCK (*thousand head*) *contd.*

DESCRIPTION	1939	1950	1951
Horses used for agricultural purposes :			
Mares (including those kept for breeding)	347	170	146
Geldings	202	119	102
Unbroken horses of one year old and over :			
Light	110	17	16
Heavy		13	9
Horses under one year old :			
Light	15	6	6
Heavy	35	4	3
Stallions being used for service :			
Light	5(4.6)	1(1.0)	1(0.9)
Heavy		1(0.6)	1(0.6)
All other horses (not entered above)	132	87	82
TOTAL HORSES	**846**	**417**	**365**

LABOUR

(*thousands*)

DESCRIPTION	1939	1950(a)	1951(a)
Regular workers :			
Male, 65 years old and over	375.3	26.7	24.7
,, 21 years old and under 65		403.9	393.2
,, 18 years old and under 21	44.7	50.4	48.4
,, under 18 years old	50.8	42.2	43.1
Total male	**470.8**	**523.2**	**509.5**
Women and girls	40.3	52.1	44.3
Total male and female	**511.1**	**575.3**	**553.8**
Women's Land Army	—	6.8	—
Casual workers :			
Male, 21 years and over	57.4	97.5	92.3
,, under 21 years old	5.9	9.6	10.2
Total male	**63.3**	**107.1**	**102.5**
Women and girls	32.7	48.3	51.8
Total male and female	**96.0**	**155.3**	**154.3**
Total male workers	**534.1**	**630.2**	**612.0**
Total female workers	**73.0**	**107.2**	**96.1**
TOTAL WORKERS	**607.1**	**737.4**	**708.1**

(a) Revised and more comprehensive instructions on the Labour Section of the form introduced for the first time in September 1948, resulted in the return of additional workers. The figures for June 1950, and June 1951, are not, therefore, comparable with those for earlier censuses.

FARMING AFFAIRS

Farm Machines and Greater Food Production Lord Carrington paid tribute to the skill and enterprise of British agricultural engineers at the annual luncheon of the Institution on May 7. "We need more food," he said, "but we have got to produce it as efficiently and as economically as we can with a declining labour force. So we must use machines as a substitute for the men who are lacking."

"The members of the Institution, as engineers, are of course primarily concerned with the technical problems of agricultural engineering, but there are wider problems of farm mechanization which all of us must constantly have in mind. I am sure that a very large part of the substantial increase in output per man which we have had in agriculture over the past few years has been due to the more extensive, the more intensive and the more intelligent use of machinery. I make this distinction between extensive and intensive use because I think it is worth emphasizing that farm mechanization is not merely a matter of providing each farmer with as many machines as he can afford. We can rely on our agricultural engineers to supply the machine—and they are supplying some very good ones—to see that they work and to see that even more efficient and useful machines are developed. But there is also the equally important problem of machinery management. This is the farmer's concern, but it is an aspect which must not be overlooked if we are to derive the maximum benefit from improvements in agricultural engineering. The machines are scarce and we badly need to export as many of them as we can, so it is essential that we should make the best possible use of the ones we keep at home. . . . This means that none of our machines should stand idle for longer than we can possibly help and that by better organization, both on the part of the individual farmer and amongst neighbours, we must see that they are used to their fullest capacity."

"A great deal of progress in mechanization has already been made and we are leading the world not only in the production of machines but also in their use. As a result of the great increase in the amount of machinery used per acre of our land, we have been able to produce food on a scale which would otherwise be quite impossible—especially if you bear in mind the increasingly heavy demands which are being made from all directions on the national labour force. When properly used, machinery is the surest way of reducing costs, and it is by reducing its costs that agriculture can make its biggest contribution to solving the economic difficulties that this country is now facing. As you all know, we have to contend with an acute shortage of foreign currencies of almost every kind and, at the same time, we are faced with the long-term problem of a continuing world shortage of food. We can help to solve both these problems if we can manage to produce a substantially larger amount of food from our own soil without having to divert productive resources from other essential uses, such as the export industry and defence."

Farming Cameo : 20. Chesterfield The Chesterfield district of Derbyshire embraces 98,000 acres of agricultural land in the north-east of the county, and supports 30,000 head of cattle, 22,000 pigs and 304,000 head of poultry. Of its 2,200 holdings, 1,500 are 50 acres and under in extent. The industrial town of Chesterfield, world-famous for the crooked spire of its Parish Church, is the geographical and cultural centre of the district.

The area is essentially one of contrasts : soils ranging from *p*H 3.5 to over 8 ; altitudes, which vary between 130 and 1,300 feet above sea level ; rainfall, in places below 25 inches and in others over 35 inches per year. First-class arable farms contrast with small, marginal, hill farms; sombre mining towns with delightful country villages of thatched cottages, or with Elizabethan mansions as the halls of Hardwick, Renishaw and Barlborough, set in their spacious parks. Finally, traversing this district, are the northward-flowing, inky-black, polluted rivers, Rother and Doe Lea : grim testimony to the existence of the washery plants of some thirty-five pits, and ancillary industries.

Geologically, there are three main formations ; Magnesian Limestone in the east, Millstone Grit in the south-west, and Coal Measures over the remainder of the area.

On the 20,000 acres of Magnesian Limestone are some fine arable farms, ranging up to 500 acres. The soils are ideal for the growing of barley, potatoes and peas. In spite of the dog menace from the neighbouring mining villages, some 6,500 sheep are kept in this area. Here, also, a considerable amount of market gardening is carried on—strawberries and broccoli being two special lines.

The Gritstone area is one of small farms, the majority under 40 acres, and characterized by stone walls enclosing fields of about 3 acres. Seventy per cent of the 10,000 acres is down to grass, and what was traditionally a rearing area is now devoted to milk production. One farmer at 1,000 feet had a herd average of 1,000 gallons in 1948 on his 100 acres ; another, with only 18 acres, produced 9,000 gallons of milk in 1951.

The economy of the Coal Measures is based on mixed farming with milk as the principal sale product. These farms, slightly larger than those of the Gritstone area, vary between 50 and 150 acres. A high degree of self-sufficiency is attained, and farmers are rapidly becoming converts to pit silage.

In all, about half of the holdings in the district are engaged in milk production, many farmers being producer-retailers. The average size of herd is fifteen cows ; the two main breeds, Friesian and Dairy Shorthorn. Some 200 holdings are producing designated milk.

Since so much of the district lies within the Coal Measures, it has felt, since 1942, the full impact of the opencast coal campaign. So far, 5,000 acres of agricultural land have been surface-worked and there are no signs of abated production. Prospecting has taken place over three times this acreage. Sites have ranged in size from 8 to 200 acres and one, which produced 500,000 tons of coal, involved parts of 16 farms. On restoration, the majority of sites are seeded down to grass.

Sixty-five per cent of the district's 10,000 acres of rough grazing are gathering grounds for reservoirs, and no cultivations are allowed. Here, from May to September, graze 600 or more cattle from lowland farms, while from October to May this land supports about 3,000 ewe and wether hoggs from the hill farms of Derbyshire.

In spite of the continual loss of land to urban development (3,000 acres since 1945) and of opencast coal activities, the Chesterfield district has consistently achieved its targets of 4,000 acres of potatoes and 11,000 acres of wheat—a large proportion of Derbyshire's quota.

E. L. Whitehouse
District Advisory Officer

Gas Liquor as a Source of Nitrogen Fertilizer The ammonia present in the gas liquor from the larger gasworks normally reaches the farmer and grower in the form of sulphate of ammonia prepared by treating the gas liquor with sulphuric acid. The recovery of ammonia in this way is, however, not an economic process for the smaller gasworks, from which about 33,000 tons of nitrogen in the form of liquor are lost every year.

But the desirability of saving this nitrogenous fertilizer and the need, because of the shortage of sulphur, to economize as much as possible in the use of sulphuric acid, have revived interest in the direct use of gasworks ammoniacal liquor on the land.

Although the liquor is fairly dilute (130–190 gallons contains the same amount of nitrogen as 1 cwt. sulphate of ammonia) it has been found to be an economic proposition to transport it as far as twenty miles from a gasworks, but obviously the shorter the distance the lower the cost.

Ammonia in the form of gas liquor has been in use for a number of years on farms in this country. For example, since 1949 the entire annual output of gas liquor from a local gas company in Lincolnshire (140–150 gallons) has been used on a 200-acre mixed farm. The liquor is supplied by the gas undertaking in a 500-gallon wheeled distributor tank.

It is applied to arable land before planting. Most of the cereals come away very proud and are grazed by dairy stock or a silage cut is taken. After this, a second application of gas liquor is made. Root crops are dressed during growth. There appears to be no adverse effect on germination nor deleterious effects from treating growing crops. The gas liquor is applied to grassland at intervals throughout the year.

In 1951, gas liquor was used on seventeen farms in the Portsmouth area under a contract scheme arranged by the Portsmouth Gas Company. About 6–7,000,000 gallons were applied to approximately 1,200 acres of arable land, leys and permanent pasture. This is equivalent to the use of up to 3 cwt. sulphate of ammonia per acre.

Gas liquor leads to a certain amount of burning when applied to grassland but the pasture quickly recovers, and thereafter the result on the growth is as good as, and at times superior to, that obtained with equivalent nitrogen dressing in the form of sulphate of ammonia or " Nitro-Chalk."

Scorching is minimized if the gas liquor can be applied in cool, moist weather. Spraying the liquor leads to losses of ammonia from the liquor and greater damage to the grass. Such losses can, however, be greatly reduced by running the liquor from the tank through trailing flexible pipes. More information of the value of gas liquor is needed and trials are in progress this season in a number of N.A.A.S. Provinces to compare dressings of gas liquor against equivalent dressings of sulphate of ammonia on winter- and spring-sown cereals, kale and potatoes.

Adequate supplies ot sulphate, potash and lime in the soil are necessary, as when any other nitrogenous fertilizer is used.

It is most important that the liquor should be completely free from tar.

Copper and Crop Protection The chance observation of a French Professor of Botany some seventy years ago gave to agricultural chemists one of the fundamental means of controlling fungus diseases of crops—copper. The first preparation, Bordeaux mixture (composed of copper sulphate and lime), achieves its protectiveness by its

excellent adhesive properties, due partly to the carbonation of excess lime in the spray deposit which thereby "mortars" fungicide to the plant leaf. Its effective use against the fungi causing Potato Blight is well known. Had it been available in the years of the Irish potato famine, thousands of lives might have been saved, and indeed it is conceivable that Irish and American history might have taken a different course.

There are, however, certain disadvantages in the use of Bordeaux mixture. Its preparation is troublesome, and its free lime content may damage some crops, but is there a more convenient mixture ? Dr. R. L. Wain discusses this question in an interesting article in *New Biology* (No. 12).* Research has revealed that some copper-containing substances are excellent in fungicidal performance, while others of similar solubility and copper content are only semi-effective or useless. Dr. Wain outlines the theories advanced to explain these variations and refers briefly to some recent experiments.

In the past few decades agricultural science has taken great strides in helping to increase world food production. Even so, the most serious problem confronting this troubled world today is shortage of food, for while world population has increased by 250 million during the last ten years, there has been but a relatively small corresponding rise in food supplies. In October 1950, the Director-General of the Food and Agriculture Organization reported : " A third of the world's people enjoy health, wealth and well-being to a comparatively high degree ; the other two-thirds live on intimate terms with poverty, hunger, disease, and premature death." They walk with the ghost of Malthus.

Crop losses due to pests and diseases are shockingly high—and of these, says Dr. Wain, " the control of plant diseases is probably even more important than the destruction of insect pests." Fungicides are invaluable in this sphere, and of those now available the substances based on copper have a major role.

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* Penguin Books, 2s.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the March 1952 *issue of* AGRICULTURE (*p.* 598), *the undermentioned publications have been issued.*

MAJOR PUBLICATIONS. Copies are obtainable at the prices quoted, from the Sales Offices of H.M. Stationery Office or through any bookseller.

Co-operative Farms and Smallholdings with Centralized Services in Wales (*New*) 2s. (2s. 1½d. by post)
Grain Storage, Drying and Marketing in the U.S.A. (*New*) 1s. 6d. (1s. 7½d. by post)

LEAFLETS Up to six single copies of Advisory and Animal Health Leaflets may be obtained free on application to the Ministry (Publications), 36-38 Chester Terrace, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from a Sales Office of H.M. Stationery Office.

Advisory Leaflets

No. 257 Green Manuring (*Revised*)
No. 356 Sugar Beet : Feeding Tops Green (*Revised*)
No. 384 The Built-up Litter System (*New*)
No. 391 Preparation of Strawberries for Market (*New*)

Animal Health Leaflets

No. 37 Pullorum Disease (B.W.D.) (*New*)
No. 20 Swine Fever (*Revised*)

MINISTRY'S PUBLICATIONS

FREE ISSUES Obtainable only from the Ministry (Publications), 36-38 Chester Terrace, Regent's Park, London, N.W.1

Fertilizers : Potatoes (*New*)
Fertilizers : Sugar Beet (*New*)
Fertilizers : Fodder Crops (*New*)

BOOK REVIEWS

The Weather. GEORGE H. T. KIMBLE. Penguin Books. 3s.

We have all met the amateur "meteorologist" (usually on holiday) to whom, by reason apparently of some specially endowed intuition, the forthcoming weather is an open book. We suffer him in the hope that his optimism may be justified and his pessimism confounded. Were it not for that *trait* of the English genius that finds a preoccupation in the weather, he would seldom, if ever, have an audience. It is a far cry, however, from this kind of charlatanism to the weather lore that was gradually built up by observation on the part of farmers and fishermen and set to rhyme to aid the memory. Not all, of course, have stood the test of time, as witness the calumny placed on St. Swithin ! But since the modern science of meteorology has shown how complex are the factors governing the weather, the marvel is not that the ancients were right so often, but that they were right at all.

That eminent geographer and meteorologist, Professor George Kimble, has written an extremely interesting (indeed I will go so far as to say absorbing) book. Its great merit, unlike many others in this field, is its readability, touched in places with a warm humour. He explains simply how the atmosphere works, what to look for in the face of the sky, the differentiating influences of the seasons and how the met. officer works. He discusses, too, whether, as is often averred, our climate is changing and, in the final chapter, whether man can (or should) exert any influence on the weather.

Professor Kimble makes the point quite early in the book that there are still many things that the professional does not know ; " when the old-timer with his weather eye proves to be nearer the mark than we are with all our paraphernalia and priestcraft." The amateur meteorologist is, therefore, still very much of account, once he has acquired the basic understanding of how the weather is made. No better guide than this book could be wished for, to put the diligent reader outside the ranks of the false prophets.

S.R.O'H.

The Hop Industry (Productivity Team Report). Anglo-American Council on Productivity. 9s. 6d.

The comprehensive report prepared by the Productivity Team which visited the U.S.A. and Canada in 1950 to study hop production methods is not only a valuable contribution to the literature of hop growing but, because of the recommendations it makes for improving the efficiency of the English industry, must also be of primary importance to every grower in this country.

In view of the suggestion that the relative cheapness of American hops is due, at least in part, to the development of machine picking, considerable space is devoted to this aspect of production. The team found that machine picking is now widely and successfully practised in the U.S.A., over 85 per cent of the total crop being gathered in this way. Growing is deliberately planned to suit machines, and yield per acre is often sacrificed to economy in picking and quality in the final product. The standard of picking is high, averaging about 4 per cent of leaf and stem in the dried sample. Most of the machines employed are of the large stationary horizontal type with an output of 25,000–35,000 lb. of green hops per 10-hour shift.

Despite the success of machines in America, the team was unable to recommend any one machine or practice which would offer a complete solution to picking problems in England. Nevertheless they emphasized that, if labour difficulties continue to increase, it may eventually be necessary to extend the use of machines in this country, and to this end they made a special recommendation for the setting up of a Hop Picking Advisory Committee to investigate the problem. This suggestion is being taken up by the Hops Marketing Board.

The report, which is amply illustrated, also deals in some detail with other points of interest in the American industry ; pests and diseases, hop varieties, layout, wiring and stringing, irrigation, machinery and buildings, drying methods, management and wages, and marketing. It shows that although strict comparisons are not easy because of differences in soil and climate, the English industry compares very favourably in many respects with its North American counterpart.

L.W.T.

Science News, No. 23. Penguin Books. 2s.

One of the most interesting articles in this issue of *Science News* is that by H. O. J. Collier, entitled "Vitamin B_{12}, Antibiotics and Growth." It outlines the knowledge we have of this important vitamin, previously described as the "animal protein factor," from its isolation in 1948 up to the present day.

After touching, not too technically, on the answers to two important questions—do organisms apart from men need vitamin B_{12}, and can it be found other than in livers, whence it was isolated ?—the author goes on to discuss the results of experiments conducted with growing chicks fed on a diet producing the vitamin, and further tests in which a pure antibiotic, e.g., aureomycin, was added to an otherwise ordinary diet. The results of the experiments, some of which are illustrated in the art inset, are as enlightening as they are important to the agriculturist. Mr. Collier also discusses briefly how exactly antibiotics have their effect on chick growth, and shows how their high potency is of the utmost importance in farm stock rearing.

Another article in this issue of agricultural interest is J. L. Cloudsley-Thompson's "Millipedes in Agriculture," in which he refers particularly to the "Spotted snake-millipede," the species responsible for ninety per cent of the damage attributed to the pest during 1944-49.

D.Z.M.

Hen Batteries. W. P. Blount. Baillière, Tindall and Cox. 15s.

It has become clear that the hen battery provides a better opportunity than any other system of poultry-keeping for careful observation of the effects of different methods of feeding and management. Individual cages make it possible not only for the food consumption and egg production of each bird to be checked, but also for the habits, vices, and general reactions of the birds to be noted. Dr. Blount, who is responsible for Hen Battery Laying Trials at Stoke Mandeville and South Cathkin, is certainly a battery enthusiast, but he is essentially an observer and experimenter and has taken full advantage of his opportunities for acquiring detailed information from these trials.

His book gives a most interesting and valuable account of those observations made over a number of years. The information given covers all aspects of battery housing, types of cages, fittings, lighting, heating, watering, and other devices. Different systems of feeding are discussed and compared, as well as different levels of food consumption, in relation to egg production.

The breeds and crosses under test have come from many different parts of the country, and as the pullets have been kept under similar environmental conditions, it has been possible to compare the returns from different breeds and cross-breds forming a representative cross-section of the poultry of this country. The figures cover not only egg production, but also the prices obtained for the carcasses of the different groups at the end of the laying period.

Alternative methods of replacing stock are discussed, and although the figures on which the calculations are based have changed considerably, it is easy to substitute present-day figures and bring the comparisons up to date.

The book also contains much general information which could be applied to other systems of poultry-keeping. It is well illustrated and conveniently indexed and, as the matter is given in a clear, readable form, it should prove to be a valuable source of data not only to hen battery specialists, but to poultry-keepers generally, in particular those who are contemplating making a start with hen batteries.

J.W.S.

Norfolk (County Books Series). DOREEN WALLACE and R. P. BAGNALL-OAKELEY. Hale. 15s.

As one might expect from the authors, this is a well-written and entertaining book but it left me with a feeling of superficiality in respect of those chapters that deal with the general description of the county and its major industry—farming.

The titles for some of the chapters are rather misleading, for whilst Breckland, The Fens, Marshland and The Broads are rightly distinguished, the remainder of the county is covered by omnibus chapters on Wool and Beer, Bread, Meat and Milk, whereas they actually cover soil types, farming techniques, and scenery, just as distinct as those to which specific chapter headings have been given. Incidentally, the chapter on Breckland covers a far wider district than that usually accepted ; and I wondered why so many pages are devoted to " Norfolk People "—particularly as the authors appear to know so little of them.

There is also evidence that the script was written some time prior to the date of publication (1951) and some checking of the material would have been advantageous ; otherwise it is extremely difficult to explain the opening paragraph of Chapter IV, which reads as follows :

That great stretch of North Norfolk which grows the best malting barley in the world, grows today, by force of circumstances, much else besides—sugar-beet and wheat by direction of the War Agricultural Committee—but if the farmers were left to their own devices it would be barley, barley all the way, with just enough fodder crops to keep a flock of sheep moving around the farm.

War Agricultural Executive Committees ceased to exist some years ago, and at no time in the county of Norfolk was it necessary to *direct* farmers to grow sugar beet, although confirmatory directions were served, and they would certainly not desire to keep a flock of sheep moving around the farm at the present time. Necton Hall, which is so correctly described as "lovely," no longer exists, for it has fallen, like so many beautiful country houses, into the hands of the house-breakers. Pull's Ferry in Norwich, " with a fine ruinous gateway," is also mentioned—but the fact that this has been most carefully restored and is now in actual use has been quite overlooked. Surely, too, in a chapter dealing with Norwich, space might have been found for some mention of the Assembly Rooms, which are not only of unique architectural interest but also play a most important part in the social and cultural life of the city.

It was a happy thought to include chapters dealing with Norfolk painting and the various aspects of the county's natural history, for they bring together in a most assimilable form very interesting material which will be read and enjoyed by visitors to the county and its residents alike. These chapters are so stimulating that many readers will be greatly encouraged to seek even more knowledge on the matters that are dealt with.

J.C.M.

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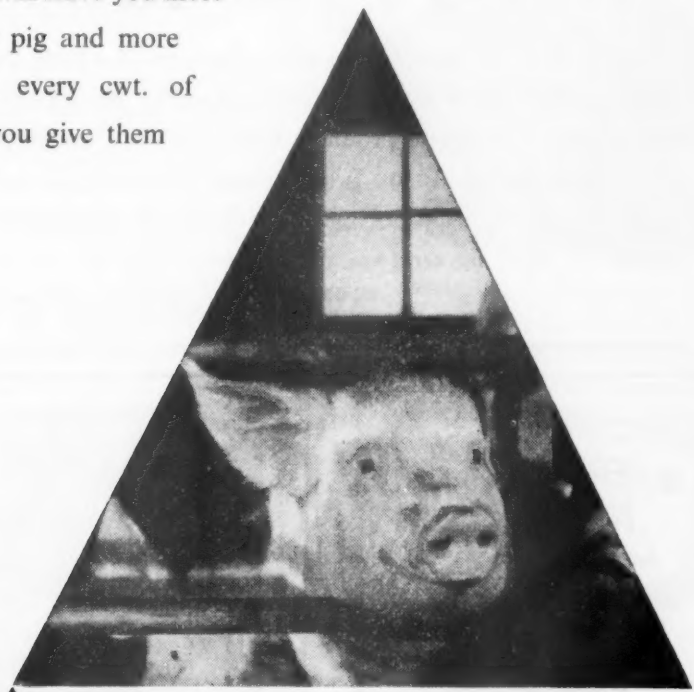

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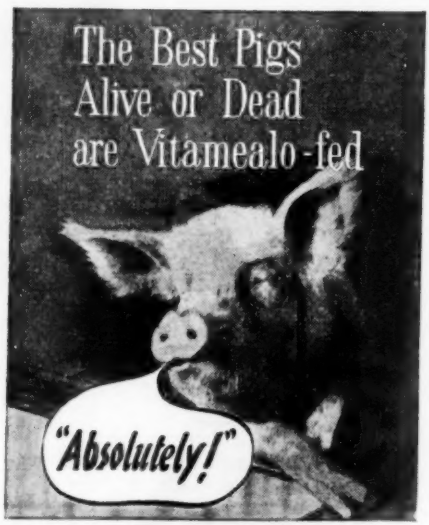

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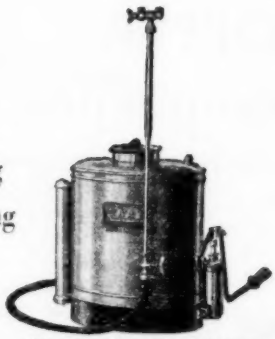

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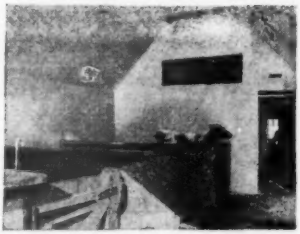

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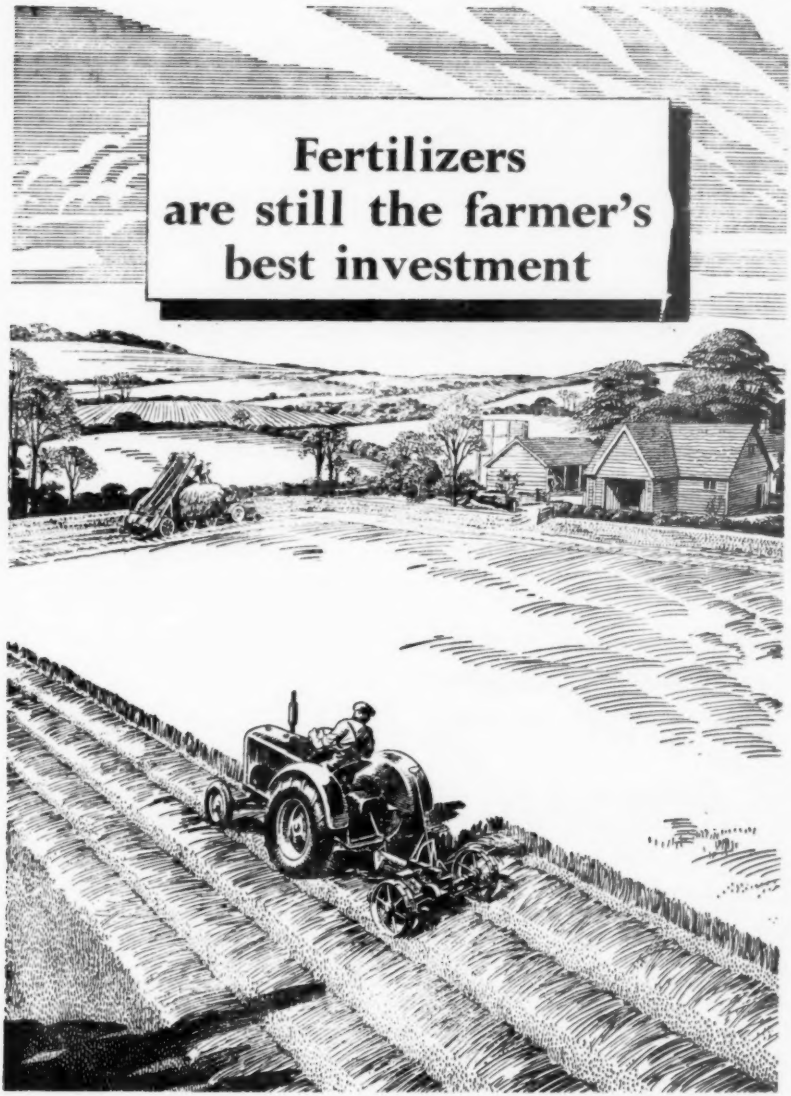

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